Figures vii  
Foreword xi  
Preface xiii  
Acknowledgments xv  
Units of Measurement xvi  

1. Controlled Directional Drilling 1  
   History 3  
   Directional Wells 4  
      Well Patterns and Applications 4  
   Well Plan 8  
   Directional Surveying 15  
   Directional Survey Tools 17  
      Drift Indicator 17  
      Magnetic Single-Shot 18  
      Magnetic Multishot 21  
      Gyroscopic Survey Tools 24  
      Steering Tools 27  
      Measurement While Drilling 28  
   Plotting Survey Results 30  
   Summary 32  

2. Deflection Tools and Bottomhole Assemblies 33  
   Types of Deflection Tools 34  
      Whipstocks 34  
      Jet Deflection Bits 36  
      Downhole Motors 37  
      Rotary Steerable Tools 42  
   Orienting Deflection Tools 44  
   Bottomhole Assemblies 46  
      Fulcrum Assembly 47  
      Pendulum Assembly 48  
      Packed-Hole Assembly 50  
      Downhole Motor Assembly 51  
   Directional Drilling Problems 51  
      Doglegs and Keyseats 51  
      Formation Factors 54  
      Hydraulics Problems 56  
      Friction 57  
   Summary 58  

3. Open-Hole Fishing 59  
   Fishing Causes 60  
      Twistoffs 60  
      Stuck Drill Pipe 61  
   Fishing Operations 66  
      Preparations 66  
      Retrieving Twistoffs 69
4. **Blowout Prevention** 101

Types and Causes 102
Warning Signs 103

Formation Pressure 104
- Formation Pressure Gradients 105
- Normal and Abnormal Pressures 108
- Hydrostatic Pressure versus Formation Pressure 110
- Pressure Surges and Swabbing 114
- Hole Filling 116
- Formation Fracture and Lost Circulation 118

Abnormally-Pressured Formations 122
- Shale Compaction 122
- Detection of Abnormal Pressure 124

Kick Detection 130
- Pit Gain 132
- Mud Flow from the Well 134
- Increase in Flow while Circulating 135
- Drilling Break 135
- Decrease in Circulating Pressure 137
- Shows of Gas, Oil, or Salt Water 137
- Gas Behavior and Gas-Cut Mud 138

Summary 141

5. **Well Control** 143

Killing a Well Kick Onshore 144
Drill Pipe as a Bottomhole Pressure Gauge 145
Slow Pump Rate 148

Well-Control Methods 149
- Driller's Method 149
- Wait-and-Weight Method (Engineer’s Method) 156
- Concurrent Method 159
- Bullhead Kill Method 160
- Dynamic Kill Method 161
- Momentum Kill Method 162

Kicks with Drill Pipe off Bottom 163
- Lubricate-and-Bleed Method 163
- Reverse Circulation 164

Mistakes in Well Control 165
Pulling into the Casing 165
Constant Pit-Level Method 165
Excessive Mud Weight 166
Constant Choke-Pressure Method 166
Kick Control in Offshore Operations 167
Diverter BOP Systems 167
Procedure to Control the Well with a Diverter System 168
Controlling a Kick from a Floating Rig with
Competent Casing Set 169
Special Problems in Kick Control 170
Shallow Gas Formations 170
Kicks with the Drill Pipe Out of the Hole 170
Stripping into the Hole 175
Stripping Out of the Hole 184
Snubbing Operations 186
Summary 190
Conclusion 191
Appendix: Figure Credits 193
Glossary 201
Index 229
Units of Measurement

Throughout the world, two systems of measurement dominate: the English system and the metric system. Today, the United States is one of only a few countries that employ the English system.

The English system uses the pound as the unit of weight, the foot as the unit of length, and the gallon as the unit of capacity. In the English system, for example, 1 foot equals 12 inches, 1 yard equals 36 inches, and 1 mile equals 5,280 feet or 1,760 yards.

The metric system uses the gram as the unit of weight, the metre as the unit of length, and the litre as the unit of capacity. In the metric system, 1 metre equals 10 decimetres, 100 centimetres, or 1,000 millimetres. A kilometre equals 1,000 metres. The metric system, unlike the English system, uses a base of 10; thus, it is easy to convert from one unit to another. To convert from one unit to another in the English system, you must memorize or look up the values.

In the late 1970s, the Eleventh General Conference on Weights and Measures described and adopted the Système International (SI) d’Unités. Conference participants based the SI system on the metric system and designed it as an international standard of measurement.

The Drilling Technology Series gives both English and SI units. And because the SI system employs the British spelling of many of the terms, the book follows those spelling rules as well. The unit of length, for example, is metre, not meter. (Note, however, that the unit of weight is gram, not gramme.)

To aid U.S. readers in making and understanding the conversion system, we include the table on the next page.
### English-Units-to-SI-Units Conversion Factors

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In this lesson:

- Overview of controlled directional drilling
- Well pattern types
- Developing the well plan
- Directional survey tools
- How computers plot survey results

Depending on the application, wells, or wellbores, can be drilled vertically or at an angle. Directional drilling is a special drilling operation employed to intentionally curve, or deviate, a well from vertical. Once the drilling operation is complete, a deviated well will follow a pre-planned path from the surface to the subsurface targets.

Today, most wells are drilled directionally. Directional drilling is implemented for a number of reasons. For example, a reservoir might be located under an obstruction, such as a building or lake, which prevents the installation of a rig directly above the target. Directional drilling might also be necessary to reach multiple reservoir locations from a single, fixed location at the surface (fig. 1). If a section of an existing well becomes blocked by fragmented drilling tools, the well can be sidetracked using directional drilling tools, thus allowing the operation to continue. Directional drilling can also be implemented to reach a more productive portion of a reservoir, and when wells are drilled directionally, a longer section of the reservoir is exposed to production. In many applications, reservoirs produce more efficiently when intercepted by wells that curve 90° or more, dubbed horizontal wells.
Deflection Tools and Bottomhole Assemblies

In this lesson:
- Why deflection tools are used
- Whipstocks and jet deflection bits
- Downhole motors
- Rotary steerable tools
- Bottomhole assemblies and their significance

A directional drilling operation requires some means of changing the course of the hole. To do so, a deflection tool can be employed to adjust the angle and direction of the well’s trajectory. Alternatively, the portion of the drilling assembly below the drill pipe, referred to collectively as the bottomhole assembly or BHA, can be adjusted so that the bit progresses in a desired direction.

A deflection tool is a device that is made up in the drill string that causes the bit to drill at an angle to the existing hole. To drill in a specific direction, the tool face of the deflection tool is turned, or oriented, to deflect the hole. The complexity of BHAs, on the other hand, ranges. A BHA might simply comprise the bit and a series of drill collars, or it might include highly sophisticated drilling tools, depending on the needs of the operation. This lesson highlights a number of deflection tools available to directional drillers as well as the BHAs that are commonly employed in the field.
In this lesson:

- Types of fish and fishing operations
- Common causes for fishing operations
- Mechanical sticking versus differential sticking
- Fishing tool types and functionality
- How to allocate time for fishing operations

The term fish refers to an obstruction in a wellbore. There are many different types of fish. Examples include stuck or broken pipe, bits and bit cones that have become detached, and various hand tools that have fallen downhole. In the field, small fish are often called junk; much larger materials, such as portions of the drill string, can likewise become lost or stuck in a hole. An operator might choose, in some cases, to bypass the fish. If not, the fish must be retrieved so that normal drilling operations can continue.

Fishing refers to the operation that is performed to retrieve fish. Fishing operations are further subdivided into two categories:

- Open-hole fishing
- Cased-hole fishing

Open-hole fishing is performed as the hole is drilled whereas cased-hole fishing is performed during production or workover. This lesson will focus on the basic techniques and tools associated with open-hole fishing—that is, the retrieval of fish from a hole that has not been cased.
 Blowout Prevention

In this lesson:

• The Lucas well and blowout at Spindletop
• Formation pressure versus hydrostatic pressure
• Causes, signs, and detection of abnormal formation pressure
• Preliminary events that indicate a kick has occurred
• Well-control equipment used to assess and detect a kick

On January 10, 1901, the blowout of the Lucas well at Spindletop near Beaumont, Texas was spectacular and widely publicized. Before the development of blowout preventers (BOPs), blowouts were common. They were called gushers if they produced oil.

The Hamill brothers had started drilling the Lucas well three months earlier using a new tool called a rotary drill. Because of their experience using the rotary drill, the Hamills had been hired by Anthony F. Lucas (fig. 99) and his partners to come to Beaumont to try drilling through the sand and rock at Spindletop.

Figure 99. Anthony Lucas, chief engineer at Spindletop
Well Control

In this lesson:

- Steps to control an onshore well kick
- Steps to control a well kick while making a trip
- Methods, procedures, and calculations used to kill a kick
- Killing a well kick with the pipe off bottom
- Common mistakes made in killing a well kick

By taking immediate action, the driller can minimize the size of a kick. Minimizing the size of the kick can greatly enhance the ability of a drilling crew to handle the kick properly. Quick action can prevent the situation from escalating into a blowout. When a kick is detected, following the proper sequence of steps is critical to successful emergency control. Depending on the cause, differing methods and procedures may be used to kill a well kick.

Lesson 5 includes a number of steps for controlling the different types of well kicks that are known to occur onshore as well as offshore. While these steps capture the sequence of events that usually take place in the field to prevent this type of emergency situation from intensifying, it is important to note that in no way should they replace the unique training and instruction that oil and gas companies might provide their employees, contractors, and associates. Even still, the protocol that has been provided herein references the common equipment, techniques, and terminologies that drilling professionals are encouraged to learn, understand, and apply whenever it is necessary. By becoming familiar with the best practices for preventing a blowout, people are more likely to stay safe, the environment is more likely to be protected, and natural resources are less likely to be wasted.
Conclusion

The five lessons in this segment of the Drilling Technology Series teach the background necessary for someone embarking on a career in drilling technology. This text examines important aspects of special drilling operations, beginning with a detailed look at controlled directional drilling and survey requirements, open-hole fishing tools and techniques, and the equipment and safety measures associated with blow prevention. Upon completing all five lessons, readers will have gained important knowledge of the major facets of drilling. To reinforce learning, an optional online assessment designed as an open-book test is available for purchase with this book. Completion of the test after reading the book provides the opportunity to receive a Completion Certificate and valuable Continuing Education Units (CEUs).

To further your understanding of rotary drilling, consider adding Segment I and II to your personal library. Segment I, Introduction to Rotary Drilling, explores the basics of petroleum geology, the rotary drilling process, and key downhole tools, such as the bit. Segment II, Routine Drilling Operations, examines important aspects of standard drilling practices, such as surface equipment, bottomhole assemblies, bit and annular hydraulics, drilling fluids, casing runs, and cementing operations. Segment IV is planned for future release; it explores critical aspects of offshore operations.

As a whole, the Drilling Technology Series includes a wealth of information about all phases of drilling. No other program in today's marketplace offers the same breadth of material in one location as this unique, easy-to-use collection. Although primarily designed for industry personnel or college students studying petroleum technology, it is useful for anyone who wants or needs to know more about rotary drilling.
Index

Throughout this index, f indicates a figure and t indicates a table on that page.

abnormally-pressured formations
  detection of, 124–129
  electric log data, 129, 129f
  heavy mud needed for, 110
  overview of, 108–109, 122
  rate of penetration and, 124–125, 136
  shale compaction and, 122–124, 123f
accelerometers, 21, 26, 26f, 28
acoustic travel time, 129
adjustable choke, 178
anchor washpipe spear, 88
annular blowout preventer, 144, 163, 176–179, 186
annular pressure, 28, 161, 182, 184, 185
annular space, 61, 112, 112f, 113, 137
associated gas, 166
atmospheric pressure, 140
azimuth, 10, 10f
backing off, 79, 86
back-pressure, 117, 133, 166, 184
back-pressure valve, 163
balled up bit, 114, 138
barite, 98, 105, 148, 150, 184, 189f
basket grapple, 72, 72f
baskets, for fishing for junk, 93–97
bent housing, 40, 41f
bent joint, 74
bent sub, 40, 41f
BHA. See bottomhole assembly (BHA).
BHP. See bottomhole pressure (BHP).
bit. See also weight on bit (WOB).
  balled up, 114, 138
  formation dip and, 54, 55f
  in the fulcrum assembly, 47, 47f
  in the pendulum assembly, 48, 49f
  jet-deflection, 36, 36f, 37, 37f
  off bottom, 86
  placing magnetic single-shot near, 20
  plugged, 184–185
  rotary steerable tools and, 42, 43f
  size of, 171
  weight of, 124, 125, 125f, 128
  whipstocks and, 34
  worn gauge areas of, 64
bit nozzles, 112–113, 137, 148, 164, 184–185
bit torque, mud temperature increase and, 128
bit walk, 54
blanket sands, 109
bleeding off, 171, 174, 174f, 175t. See also lubricate-and-bleed method.
blind ram preventer, 178
blind rams, 177, 178, 181. See also ram-to-ram stripping.
blowout preventers (BOPs)
  annular, 144, 163, 176–179, 186
  causing pressures on drill pipe and casing, 145
  closing causing annular pressure, 147
  closing during a well kick, 134f, 144, 145, 146f, 169
  development of, 101, 103
  diverter, 167–168
  gas pressure and, 139
  importance of understanding protocol with, 143, 190
  reopening, 153
  stripping through, 170, 176, 178
blowout prevention. See kick detection; well control.
blowouts. See also formation pressure; kick; kick detection; well control.
  advent of controlled directional drilling and, 4, 5f
  causing sticking, 62, 62f
  dangers from, 141, 143
  offshore, 104
  overview of, 101–102, 141, 152f
  types and causes, 102–103
  underground, 102, 121, 161, 188
  warning signs, 103–104, 131, 141, 168
boot baskets/boot sub, 94, 95f
BOPs. See blowout preventers (BOPs).
bore, 83
borehole
  becoming unstable due to sloughing shale, 126
  gas in, 149, 150
  pressure in, 110, 114, 118
bottom out, 4
bottomhole assembly (BHA)
  adjusting, 33, 54
  downhole motor type, 51
  fulcrum type, 47–48
  inadequate hole cleaning and, 63, 63f
  measuring vibrations in, 28
  overview of, 46, 58
  packed-hole type, 50, 50f
  pendulum type, 48, 49f
  stuck in a sloughing hole, 61, 61f
bottomhole cleaning, 124
bottomhole pressure (BHP)
  closed wells and, 149
  excessive mud weight and, 166
  gas-cut mud and, 140, 140f
Special Drilling Operations

- gauging with drill pipe in, 145–147, 146f, 171–172
- gauging with drill pipe out, 172–174
- hydrostatic pressure and, 111f, 112
- of the Lucas well, 104
- stripping and, 182, 185
- trips out and, 131
- box. See tool joints.

- Boyle, Robert, 138
- Boyle's law, 138–139, 138f
- brackish muds, 128
- bridge (obstruction), 37
- bridge plug, 15
- building assembly. See fulcrum assembly.

- buildup rate (BUR), 9, 11, 48, 51
- bullhead kill method, 160, 161f, 170
- bumper sub
  - in a washover, 79, 81
  - in the fishing string assembly, 71, 74, 86, 86f
  - keyseats and, 86
  - position of before a downward blow, 87f

- BUR. See buildup rate (BUR).

- cable-guide assembly, 91, 91f
- caprock, 6
- cased-hole fishing, 59
- casing. See also washover pipe.
  - crooked wells and, 3
  - friction and, 57
  - magnetization of, 20
  - offshore drilling issues and, 167
  - pulling into, 165
- casing pressure. See also shut-in casing pressure (SICP).
  - during stripping on the rams, 182
  - gas migration and, 140, 173, 174f
  - increases in, 147
  - in the driller's method, 150–151, 153
  - in the wait-and-weight method, 157–158
  - monitoring, 145, 149, 170
  - volumetric displacement correction in, 182–183, 183f

- casing seat, 120, 166
- casing shoe, 119, 156
- casing whipstock, 34, 35f
- caustic soda, mud temperature increase and, 128
- cavings, 83, 83f
- center-prong rope spear, 90
- centralizers, 57
- centrifugal pumps, 117
- chemical cutters, 84–85, 85f
- chloride in mud, 128, 131
- choke
  - adjustable, 169, 178
  - circulation loss and, 188
  - in a competent casing set, 169
  - in a well shut-in, 144

- in the constant choke-pressure method, 166
- in the constant pit-level method, 165
- in the driller's method, 151–153
- in the wait-and-weight method, 157–158
- choke manifold, 149, 178, 182
- choke-manifold friction, 159
- circulate-and-weight method, 159
- circulating whipstock, 34
- circulation. See also lost circulation.
  - decrease in, 168
  - differential sticking and, 87
  - during a fishing operation, 68, 72, 73, 74
  - for jarring, 76
  - hydrostatic pressure and, 111f
  - in a washover, 82
  - in the concurrent method, 159
  - in the driller's method, 149–155
  - in the wait-and-weight method, 156–159
  - increases in flow, 131
  - reduction in BHP and, 131
  - schematic of, 130f
- circulation pressure
  - decreases in, 131, 137, 148
  - in a positive-displacement motor, 39
  - pressure and, 112–113, 113f
  - recording, 148, 149
  - to overcome friction, 112–113, 113f
- circulation rate
  - BUR and, 48
  - drilling fluid and, 56, 56f
  - low, 63
  - mud temperature increase and, 128
- close, survey, 31, 31f
- closed in well, 133, 144
- closed reservoirs, 109
- closing unit pumps, 176
- coiled tubing, 83
- competent casing set, well kick and, 169
- concurrent method, 159
- conductivity, 129
- conductor pipe, 167
- connection gas, 127
- constant choke-pressure method, 166
- constant pit-level method, 165
- controlled directional drilling. See directional drilling.
  - core-type junk baskets, 94
  - cork screw drill pipe, 65, 65f
  - course length, 9, 10, 31, 53
  - cross-flow, 188
  - cumulative error, 31
  - cutters, for drill pipe, 83–85
  - cuttings, 34, 56, 56f, 83, 83f
debris, 79, 91, 96
declination. See magnetic declination.
deflection, 4, 6
deflection tools. See also directional drilling.
downhole motors, 37–42
formation factors and, 54
jet deflection bit, 36, 36f, 37f
orienting, 44–46, 44f
overview of, 33, 58
rotary steerable tools (RSTs), 42–43
types of, 34–43
whipstocks, 34, 35f
density, adjusting in drilling fluid, 56
depth. See also measured depth (MD); true vertical depth (TVD).
fluid pressures and, 107, 107f, 141
formation compaction and, 123f, 127, 129
of broken drill string, 66, 67f
pressures and, 104, 106, 110
total, 4
well types and, 6
derrickhand, 91, 104
deviated well, 1
deviation, 8, 9
d-exponent, 125, 125f
DHSV. See downhole safety valves (DHSV)s.
differential pressure, 96, 124
differential sticking, 46, 65, 65f, 87–88
direction, well, 21, 27, 28, 31, 45f
directional drilling. See also deflection tools.
advantages of, 32
BHA and, 46
dogleg severity (DLS) and, 51, 52f
formation factors in, 54
friction and, 57, 57f
history of, 3–4
hydraulics problems in, 56
keyseats and, 52f
overview of, 1, 2
plotting survey results for, 30–31, 30f
problems in, 51–57, 58
reasons for, 1
surveying, 15
well patterns and applications, 4–6, 5f, 7f
well plans and, 8–15
directional drilling service companies, 4, 8, 32
directional drilling supervisor, 4

displacement by the drill collar, 118, 182
by the drill pipe, 163, 185, 185f
monitoring during stripping in, 178, 182
mud, 182
volumetric corrections for, 182–183, 183f
diverter BOP system, 167–168
dogleg, 51–52, 53f, 63
dogleg severity (DLS), 17, 51, 52f
DOR. See dropoff rate (DOR).
down dip, 54, 55f
downhole motors
overview of, 37, 51, 58
positive-displacement motor, 38–39, 38f, 39f
steering tools and, 28
turbine motors, 40–42, 40f
downhole safety valves (DHSV)s, 15
downhole turbine motor, 40–42, 40f
downlink systems, 43
dress (the drill pipe), 68
drift, 21, 27, 28, 31
drift angle
calculating, 11, 45, 45f
friction and, 57f
gradual changes in, 53
pendulum effect and, 48
taking into account for measured depth, 9
the BHA and, 46
drift indicator, 17, 17f
drill collars
displacement of mud by, 118, 182
for a fishing string assembly, 71
for a washover pipe, 81
fulcrum assemblies and, 47
in a packed-hole assembly, 50
in a pendulum assembly, 48
magnetization of, 20
pressure loss and, 112
recovering, 89
size of and directional drilling, 46, 48
stuck in a keyseat, 86
drill pipe
as BHP gauge, 146–147, 146f
calculating how much is needed to reach the fish, 71
cutting, 83–85
directional drilling and, 46
displacement of mud by, 163, 185, 185f
friction causing wear in, 57
gas associated with connections in, 127
hole in, during a kill operation, 184
movement causing changes in, 115
off bottom, well kicks and, 163–165
out of hole, well kicks and, 170–175
plugged, 184–185
reactive torque and, 41
twistoffs of, 60, 60f, 69–70
drill pipe pressure
imbalance inside and out, 137
loss of, 112
measuring, 145
reducing to improve circulation, 189f
to kill the kick, 172
tracking, 149
drill pipe pressure gauge, 157
drill pipe rubbers, 180
drill site, 1, 2f, 4f
drill stem, 46
drill string
controlling bend of through BHA, 46
deflection tools on, 33
downhole motor on, 37
fishing for, 52
forces exerted onto, 175
friction in, 57
length and friction loss, 112
measuring for a fishing operation, 66, 67f
reactive torque and, 41
sagging during directional drilling, 56
sloughing shale and, 126
drilled show, 127, 137. See also formation fluids.
driller's method (well control), 149–155
drilling break, 124, 131, 135–136, 168
drilling fluid. See also mud.
carrying capacity of, 56, 56f
causing wall collapse, 61
chloride measurements in, 128
density of for differing pressures, 110, 110t
downhole turbine motor in, 40
for a fishing operation, 73
for hydraulic-powered junk baskets, 96
hydrostatic pressure and, 108
junk in, 94
properties of and rate of penetration, 124
shale entering, 126
to power positive-displacement motor, 38–39
using oil-emulsion mud to reduce friction, 57
drilling out, 83
drillout tool, 83
drill-stem valve, 145
drop assembly. See pendulum assembly.
dropoff rate (DOR), 9, 48
dump valve, 40
dynamic kill method, 161–162
Eastman, H. John, 3
ECD. See equivalent circulating density (ECD).
electric log data, 129, 129f
electric well log, 66
electric wireline, 78
electromagnetic field, 78
electromagnetic telemetry systems, 28
engineer's method, 156–159
entrained gas, 148
environment, protecting through well control, 143
equivalent circulating density (ECD), 167
exploration well, 6
explosives, 78, 79, 84, 97
extension sub, 74
false readings, 20
fault, 6
fault plane, 6
FCP. See final circulating pressure (FCP)
ferrous metal, 94, 96
film disc, magnetic single shot, 20
filter cake, 62, 65, 87
final circulating pressure (FCP), 137
finger-type junk basket. See poor boy junk baskets.
fish
damaged top, 74
engaging, 73–75
milling, 69–70
overview of, 59
plugged, 83, 83f
well patterns and, 6
fishing. See also open-hole fishing operations.
calculating days for, 98–99
decisions about, 100
economics of, 52, 98–99, 100
overview of, 52, 59
fishing magnets, 96, 97f
fishing string assembly
jarring and, 76
keyseats and, 86
overview of, 71–72, 71f
to engage the fish, 73
fishing tool, selecting, 68
float, 145
floating rig, controlling a kick, 169
flow check, 115, 134
flow line, 137
fluid friction, 112
fluid pressure, 107, 107f, 123, 161–162
flush-joint casing, 57
formation dip, 54
formation fluids. See also drilled show; kick; shows.
entering mud due to increasing pore pressure, 128
entering the hole, 62, 102, 108
in a surface blowout, 102
pit-level gain and, 150
swabbing and, 114–115, 138
formation pore pressure, 119f, 123, 127, 129
formation pressure. See also blowouts.
abnormal, 122–129
Conroe blowout and, 4
INDEX

electric log data, 129, 129f
equalizing with BHP, 149
gradients in, 105–107
hole filling, 116–118
normal and abnormal, 108–109
overview of, 104
rate of penetration and, 124
SIDPP and, 145
surges and swabbing, 114–115
versus hydrostatic pressure, 110–113
formations
breakdown of in reverse circulation, 164
changes in while drilling, 135
detecting a change in, 124
factors in, 54, 55f
fracture of and lost circulation, 118–121
fracturing with bullheading method, 160
high-permeability and kicks, 133
overview of, 104
permeable, 65, 87, 106, 121, 123
soft, 36, 48, 124, 126, 135
stratigraphic oil trap, 105
FOSV. See full-opening safety valve (FOSV).
fracture pressure, 118–119, 119f, 120
free water, 124, 127
free-point indicator, 77–78, 77f, 78f, 86
friction, 57, 57f, 82, 112–113, 159
fulcrum assembly, 47–48, 47f, 58
fulcrum effect, 47, 47f
full-opening safety valve (FOSV), 145, 163
gas, show of, 137–138
gas bubble migration, 139, 139f, 160, 170–171, 175f, 189
gas cap, 6
gas drive, 6
gas expansion, 137
gas kick
  circulating out, 150, 152–153, 153f, 166
  mistakes in, 163
  onshore, 144
  shallow, 145, 170
  understanding gas behavior, 138
gas sands, 118, 127, 137
gas wells, 160
gas-cut mud, 127, 131, 138–140, 140f. See also mud.
gel strength, 112
gradient, 145
grapples, 72, 72f, 73
gravity-fill tank, 117, 118
grid north, 10
gushers, 101
gyrocompass, 24
gyrocope, 24
gyroscopic tools, 24–26, 24f, 25f
hard shut-in, 144, 169
high-permeability formations, 133
hole, 15, 46, 147
hole filling, 116–118
hook load, 73, 104, 187
horizontal deviation, 6
horizontal direction, 53
horizontal drain hole, 6
horizontal slab plot, 12, 13f
horizontal structure plot, 11, 14f, 12f
horizontal wells, 1
Huntington Beach, CA oilwells, 3, 3f
HWO. See hydraulic workover (HWO) unit.
hydraulic fishing jar, 76, 76f, 81
hydraulic rig-assist snubbing unit, 186
hydraulic systems, 51, 56
hydraulic workover (HWO) unit, 186–187, 187f
hydraulic-powered junk baskets, 96
Hydrill® annular preventer, 179, 179f
hydrostatic head, 112
hydrostatic junk baskets, 96
hydrostatic pressure
  blowouts and, 102
  calculating, 106–107, 106f
  drilling fluid and, 108, 111–112, 111f
  filter cake formation and, 65
  formation fracture pressure and, 118
  formation pressure gradients and, 105–106, 109f
  imbalances of, 137
  of the Lucas well, 104
  rate of penetration and, 124
  shallow wells and, 104
  SIDPP and, 145
  soft shale and, 126
  swabbing and, 114
type of kick when formation is underbalanced, 133
versus formation pressure, 110–113
hydrostatic-pressure gradient, 107
ideal gas, 138
impression blocks, 68, 68f
initial circulating pressure (ICP), 157
internal diameter (ID), 112
internal fishing tools, 70, 70f
International Association of Drilling Contractors (IADC), 154
isogonic charts, 22, 22f, 23f
jar accelerator, 71, 76, 81
jarring, 71, 76, 76f, 81, 87–88
Special Drilling Operations

jet cutters, 84, 85f
jet deflection bit, 36, 36f, 37f
jet-powered junk baskets, 96
junk, 59, 64, 64f, 93–97
junk shots, 96–97
kelly, 134, 144, 145
keyseat reamer/wiper, 86, 86f
keyseats, 52, 53f, 63, 63f, 86
kick. See also blowouts; formation fluids.
controlling during a trip, 145
controlling with the bullhead kill method, 160, 161f
controlling with the concurrent method, 159
controlling with the dynamic kill method, 161–162
controlling with the momentum kill method, 162
controlling with the wait-and-weight method, 156–159
formation pressure gradients and, 105
hole in the drill pipe and, 184
imminent, 141
killing onshore, 144–145
lost circulation and, 118, 121, 188–189
minimizing size of, 143
most dangerous type, 133
offshore drilling, 167–169
overview of, 102, 141
plugged pipe or bit and, 184–185
pulling in the casing and, 165
reverse circulation and, 164
shallow gas formations, 170
snubbing operations for, 186–189
stripping into the hole and, 175–183
stripping out of the hole and, 184–185
swabbing and, 114
with drill pipe off bottom, 168–169
with the drill pipe out of the hole, 170–175
kick detection. See also blowouts.
decrease in circulating pressure, 137
drilling break, 133–136
gas behavior and gas-cut mud, 138–140
importance of following protocol in, 143, 190
increase in flow while circulating, 135
indicators and, 131
mud flow from the well, 134
overview of, 130, 130f, 141
shows of gas, oil or salt water and, 137–138
kicked off, 4
kickoff point (KOP), 4, 6, 10
kill fluids, 161, 162
kill procedures. See well control.
kill sheets, 154–155, 154f, 156f, 157–158
killing a well. See well control.
kill-weight mud, 150, 157, 159
knocker sub, 76
kneuckle joint, 74–75, 75f
KOP. See kickoff point (KOP).
large-diameter holes, 46
leading the hole, 54
leak-off test, 119–121, 120f
liners, 117
lobes, in a rotor, 38f, 39, 39f
logs, analyzing, 129, 129f
looking up. See tool face orientation.
loss zone, 121
lost circulation. See also circulation.
after pulling the drill pipe, 117
causing mechanical sticking, 63
due to excessive mud weight, 166
formation fracture and, 118–121
formation types and, 121, 121f
from a blowout, 62, 62f
from inadequate hole cleaning, 63, 63f
from sloughing holes, 61, 61f
from undergauge holes, 62, 62f
managing, 188–189
when stripping on the rams, 182
lost returns, 118
low-permeability formations, 133, 160
lubricate-and-bleed method, 163–164, 170. See also bleeding off.
Lucas, Anthony F., 101, 101f
Lucas well, 101–104, 102f
magnet inserts, for catching junk, 94
magnetic declination, 22
magnetic field, 20, 24
magnetic multishot, 21, 21f
magnetic north, 22
magnetic poles, 22
magnetic reading, 22
magnetic single-shot, 18–20, 18f, 19f, 20f
magnetometers, 21, 28
magnets, 96, 97f
make hole, 28
managed pressure drilling (MPD), 108
mandrel knocker, 76
measured depth (MD), 8–9. See also depth.
measurement while drilling (MWD), 15, 28, 29f, 30, 40
mechanical sticking
blowout sticking, 62, 62f
caused by a tapered hole, 64, 64f
caused by cork screwed drill pipe, 65, 65f
caused by junk in the hole, 64, 64f
due to inadequate hole cleaning, 63
keyseats, 63, 63f
sloughing holes, 61, 61f
undergauge holes, 62, 62f
mechanical sticking, retrieving pipe
  backing off, 79
  cutting pipe, 83–85
  drilling out, 83
  finding the stuck point, 77–78
  jarring, 76
  washovers, 79–82
metering devices, 78
mill, 69, 69f
mill shoe, 94
milling (junk), 68
momentum kill method, 162
Monel steel, 20
MPD. See managed pressure drilling (MPD).
mud. See also drilling fluid; gas-cut mud.
  bleeding during stripping in, 178
  changing properties of for differential sticking, 87
  chloride in, 128, 131
  downhole turbine motor in, 40
  flowing when pumps are off indicating a kick, 131, 168
  formation pressure and, 105
  friction losses and, 112
  importance of measuring volume of, 116–117
  oil-emulsion, 57
  pressure and, 114
  temperature increases in, 28, 128, 128f, 131
mud motor. See downhole motors.
mud pit, 117, 131, 132–133, 168
mud pressure, 133
mud pumps, 148, 149–150
mud return flow rate, 135
mud return line, 131
mud weight
  calculating to kill a well, 145, 146
  differential pressure and, 122
  excessive, 166
  fracture pressure and, 119, 120, 121, 124, 127, 127f
  gas entering due to insufficiencies in, 127
  increasing if necessary during the trip out, 131
  using the driller's method to kill a well and, 149, 150–151
mud-gas separator, 148
mud-pulse telemetry, 28
MWD. See measurement while drilling (MWD).
natural migration of gas, 127
natural resources, protecting through well control, 143
  nomographs, 179
nondirectional hole, 15
nonmagnetic drill collar (NMDC), 20, 21, 28, 29f
nonretrievable whipstock, 34
normal pressures, 108–109
normalized penetration rates, 125, 125f
north-seeking gyros, 26
nozzles. See bit nozzles.
objective (of the drilling), 8
OD. See outside diameter (OD).
offshore wells
  blowouts, 104
  directional drilling to reach, 5f
  directional surveying and, 15
  kick control in, 167–169
  killing, 144
  stripping in, 179
  oil, 137–138, 150
oil spotting, 88, 88f
oil-emulsion mud, 57
on bottom, 39, 67f, 144–145
open holes, 20
open-hole fishing operations. See also fishing.
  backing off, 79
  by drilling out, 83–85
  by jarring, 76
  causes for, 60–65, 100
  economics of, 98–99, 100
  engaging the fish in, 73–75
  finding the stuck point, 77–78
  for junk, 93–97
  keyseats and, 86
  preparing for, 66, 67f, 68
  string assembly for, 71–72
  to free wall-stuck pipe, 87–88
  to retrieve drill collars, 89
  to retrieve twistoffs, 69–70
  to retrieve wireline, 90–92
  washover and, 79–82, 80f
operating pressure, 151
operator, 66, 99, 118
oriented. See tool face orientation.
Ouija Board, 44–45, 44f
out-running the well, 162
outside cutter, 84, 84f
outside diameter (OD), 64
overbalance of pressure, 108
overburden, 109, 123
overkill, allowing for, 166
overpressured formation, 124
overpulls, 84
overshot
  external diameter of, 71
  fishing for wireline, 90–92, 92f
  for fishing, 70, 70f, 72, 73f
  to recover drill collars, 89
  to retrieve a magnetic single shot, 20
  unsuccessful, 74
  with a wall hook, 75f
Special Drilling Operations

packed-hole assembly, 50, 50f; 54, 58
pay zone, 4, 6
pendulum assembly, 48, 49f; 58
pendulum effect, 48
permeability, 122, 122f; 124
permeable foundation, 65, 87, 106, 121, 123
pilot, 70
pilot mill, 70, 71f
pin, 40, 89
pipe rams, 178
pit gain, 131, 132–133, 132f; 140, 155
pit tanks, 132
pit-level changes, 116, 118, 153, 165, 188
pit-level indication system, 132, 132f; 133, 144, 145
plan view, 8, 10
plugs, 74
plumb bob, 17
point-the-bit rotary steerable, 42, 43f
poor boy junk baskets, 93–94, 93f; 94f
pore pressure, 128
pores, 122, 122f; 124
porous rock, 122
positive-displacement meter, 117
positive-displacement motor, 38–39, 39f; 39f
pressure gradient, 106, 110f
pressure loss, 39
pressure surges, 114–115
pressure transducer, 28
pump, 144
pump pressure, 39, 73, 112–113
pump rate, 150, 160, 162
pump stroke count, 116, 117
pump-in pressure, 120
push-the-bit rotary steerable, 42, 43f
quadrant system, 10, 10f
rams, 176–177
ram-to-ram stripping, 180–182
rate gyros, 26, 26f
rate of penetration (ROP)
balancing with DOR and rotary speed, 48
calculating, 125f
decreases in, 136
gas-bearing sands and, 127
hydraulic systems and, 56
sudden increases in, 131, 135, 136f
watching for changes in to detect abnormal pressures, 124–125, 136
reactive torque, 41–42
reaming, 34, 35f; 64, 86, 86f
reciprocating pump, 117
recording devices, 132–133
regulator valve, 176, 176f
relief well, 4
reservoir pressure, 103, 104, 161
reservoir rock, 122
reservoirs, 1, 2f; 5f
resistivity, 129
restriction plug, 74
retrievable whipstock, 34
reverse circulation, 164
reverse-circulation junk baskets, 96
risk-prone areas, 15
roller cone bit, 36
ROP. See rate of penetration (ROP).
rotary, 92, 134, 144, 145
rotary circulating system, 148f
rotary drill/drilling, 101, 102
rotary shoes, 79, 81, 82
rotary speed, 28, 39f; 124, 125, 128
rotary steerable tools (RSTs), 42–43, 43f
rotary table, 8
rotation, 82
rotor, 38–39, 39f; 40
RST. See rotary steerable tools (RSTs).
safety
blowouts, 103
downhole safety valves (DHSV), 15
during stripping in, 177
during stripping out, 185
factor, adding in, 158
if a kick is imminent, 141
importance of following protocol and, 143, 190
intersecting wells, 15
safety joints, 79, 81, 89, 89f
salt dome overhangs, 6
salt water, 40, 137–138, 150
sand formations, 109, 127
seawater muds, 128
sediments, 122–123, 123f
seismic data, 124
Seminole field, 3
set back (fishing), 66
shale
closed reservoirs with, 109
compaction of, 122–124, 129
density of, 127
detecting abnormal pressure in, 124
gas in, 127
log measurements of, 129
sloughing, 61, 126, 126f
swelling of causing an undergauge hole, 62, 62f
<table>
<thead>
<tr>
<th>Term</th>
<th>Page(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>shale shakers</td>
<td>150</td>
</tr>
<tr>
<td>shallow gas formations</td>
<td>170</td>
</tr>
<tr>
<td>shallow gas kick</td>
<td>144</td>
</tr>
<tr>
<td>shaped charge</td>
<td>84, 97</td>
</tr>
<tr>
<td>short way (reverse circulation)</td>
<td>164</td>
</tr>
<tr>
<td>shows</td>
<td>127, 131, 137–138, 168. See also formation fluids.</td>
</tr>
<tr>
<td>shut-in casing pressure (SICP)</td>
<td>144, 145, 149, 155, 157</td>
</tr>
<tr>
<td>in BHP calculations</td>
<td>172</td>
</tr>
<tr>
<td>recording</td>
<td>144, 145, 149, 155, 157</td>
</tr>
<tr>
<td>stripping the hole and</td>
<td>175</td>
</tr>
<tr>
<td>using difference to SIDPP for calculations</td>
<td>147</td>
</tr>
<tr>
<td>shut-in drill pipe pressure (SIDPP)</td>
<td>144, 145, 147, 155, 157</td>
</tr>
<tr>
<td>shut-in well</td>
<td>102, 104, 144</td>
</tr>
<tr>
<td>SICP. See shut-in casing pressure (SICP).</td>
<td></td>
</tr>
<tr>
<td>sidetracked well</td>
<td>1, 3</td>
</tr>
<tr>
<td>SIDPP. See shut-in drill pipe pressure (SIDPP).</td>
<td></td>
</tr>
<tr>
<td>slanthole drilling</td>
<td>4</td>
</tr>
<tr>
<td>slips</td>
<td>84, 145</td>
</tr>
<tr>
<td>sloughing shale</td>
<td>61, 61f, 68, 126, 126f</td>
</tr>
<tr>
<td>slow pump rate</td>
<td>148, 157</td>
</tr>
<tr>
<td>slug (oil)</td>
<td>88, 88f</td>
</tr>
<tr>
<td>small-diameter holes</td>
<td>46</td>
</tr>
<tr>
<td>snake/swivel connector grip</td>
<td>92</td>
</tr>
<tr>
<td>snubbing</td>
<td>163–164, 170</td>
</tr>
<tr>
<td>snubbing unit</td>
<td>177, 180, 187f</td>
</tr>
<tr>
<td>soft formations</td>
<td>36, 48, 124, 126, 135</td>
</tr>
<tr>
<td>soft shut-in</td>
<td>144, 146, 169</td>
</tr>
<tr>
<td>spear</td>
<td>70, 70f</td>
</tr>
<tr>
<td>Spindletop</td>
<td>101</td>
</tr>
<tr>
<td>spiral grapple</td>
<td>72</td>
</tr>
<tr>
<td>spiral hole</td>
<td>51</td>
</tr>
<tr>
<td>squeeze cementing</td>
<td>118</td>
</tr>
<tr>
<td>stabilizers</td>
<td></td>
</tr>
<tr>
<td>fulcrum as</td>
<td>47</td>
</tr>
<tr>
<td>in a downhole motor assembly</td>
<td>51</td>
</tr>
<tr>
<td>in a packed-hole assembly</td>
<td>50</td>
</tr>
<tr>
<td>in a pendulum assembly</td>
<td>48</td>
</tr>
<tr>
<td>to prevent sagging drill string</td>
<td>56</td>
</tr>
<tr>
<td>stack</td>
<td>178, 180</td>
</tr>
<tr>
<td>stages</td>
<td>38–39, 38f, 39f, 40</td>
</tr>
<tr>
<td>stand</td>
<td>33</td>
</tr>
<tr>
<td>stand-alone unit</td>
<td>186</td>
</tr>
<tr>
<td>standpipe</td>
<td>73, 151</td>
</tr>
<tr>
<td>stationary slips</td>
<td>186</td>
</tr>
<tr>
<td>stators</td>
<td>58, 40, 40f, 41</td>
</tr>
<tr>
<td>steerable motor</td>
<td>40</td>
</tr>
<tr>
<td>steerable system</td>
<td>40</td>
</tr>
<tr>
<td>steering tools</td>
<td>27–28, 27f</td>
</tr>
<tr>
<td>stiff assembly. See packed-hole assembly.</td>
<td></td>
</tr>
<tr>
<td>straight hole</td>
<td>15, 51</td>
</tr>
<tr>
<td>strata</td>
<td>54, 104, 105f</td>
</tr>
<tr>
<td>stratigraphic formations</td>
<td>105f</td>
</tr>
<tr>
<td>string shot assembly</td>
<td>77f, 78, 86</td>
</tr>
<tr>
<td>stripping</td>
<td></td>
</tr>
<tr>
<td>in procedures for</td>
<td>175, 178</td>
</tr>
<tr>
<td>volumetric displacement correction in</td>
<td>182–183, 183f</td>
</tr>
<tr>
<td>with ram preventers</td>
<td>180–182</td>
</tr>
<tr>
<td>with the annular preventer</td>
<td>176–179</td>
</tr>
<tr>
<td>with the BOP</td>
<td>170</td>
</tr>
<tr>
<td>with the lubricate-and-bleed method</td>
<td>163</td>
</tr>
<tr>
<td>stripping out</td>
<td>184–185</td>
</tr>
<tr>
<td>stuck drill pipe</td>
<td></td>
</tr>
<tr>
<td>cutting</td>
<td>84</td>
</tr>
<tr>
<td>determining</td>
<td>66</td>
</tr>
<tr>
<td>differential sticking</td>
<td>65, 65f, 88, 88f</td>
</tr>
<tr>
<td>due to sloughing shale</td>
<td>126</td>
</tr>
<tr>
<td>freeing from a keyseat</td>
<td>86</td>
</tr>
<tr>
<td>mechanical sticking</td>
<td>61–65, 76–85</td>
</tr>
<tr>
<td>overview of</td>
<td>61</td>
</tr>
<tr>
<td>preventing during a blowout</td>
<td>165</td>
</tr>
<tr>
<td>stuck point, finding</td>
<td>77–78</td>
</tr>
<tr>
<td>sub mandrel</td>
<td>86</td>
</tr>
<tr>
<td>subnormal pressures</td>
<td>108–109</td>
</tr>
<tr>
<td>suction pit</td>
<td>156, 157</td>
</tr>
<tr>
<td>supervisory personnel</td>
<td>144, 145</td>
</tr>
<tr>
<td>surface blowout</td>
<td>102</td>
</tr>
<tr>
<td>surface pressure</td>
<td>133, 161, 175</td>
</tr>
<tr>
<td>surge bottles</td>
<td>177, 177f</td>
</tr>
<tr>
<td>surveying, directional</td>
<td>15, 16f</td>
</tr>
<tr>
<td>surveying, directional, tools for</td>
<td></td>
</tr>
<tr>
<td>drift indicator</td>
<td>17, 17f</td>
</tr>
<tr>
<td>friction and</td>
<td>57</td>
</tr>
<tr>
<td>gyroscopic</td>
<td>24–26</td>
</tr>
<tr>
<td>magnetic multishot</td>
<td>21, 21f</td>
</tr>
<tr>
<td>magnetic single-shot</td>
<td>18–20, 18f, 19f, 20f</td>
</tr>
<tr>
<td>measurement while drilling (MWD)</td>
<td>28, 29f</td>
</tr>
<tr>
<td>orienting</td>
<td>45f, 46</td>
</tr>
<tr>
<td>plotting results of</td>
<td>30–31, 31f</td>
</tr>
<tr>
<td>steering tools</td>
<td>27–28, 27f</td>
</tr>
<tr>
<td>surveying service companies</td>
<td>4, 21</td>
</tr>
<tr>
<td>swabbing</td>
<td>114–115, 131, 138, 163</td>
</tr>
<tr>
<td>taper tap</td>
<td>89, 89f</td>
</tr>
<tr>
<td>tapered holes</td>
<td>64, 64f</td>
</tr>
<tr>
<td>target</td>
<td>8</td>
</tr>
<tr>
<td>temperature, mud</td>
<td>28, 128, 128f, 131</td>
</tr>
<tr>
<td>tension</td>
<td>87</td>
</tr>
<tr>
<td>threads</td>
<td>40, 89</td>
</tr>
<tr>
<td>TIW valve</td>
<td>163</td>
</tr>
<tr>
<td>tool face orientation</td>
<td></td>
</tr>
<tr>
<td>during a fishing operation</td>
<td>75</td>
</tr>
<tr>
<td>for deflection</td>
<td>33</td>
</tr>
<tr>
<td>in a bent sub</td>
<td>40</td>
</tr>
<tr>
<td>looking up</td>
<td>79</td>
</tr>
<tr>
<td>measuring</td>
<td>19, 21</td>
</tr>
</tbody>
</table>
monitoring with steering tools, 27
technology for, 44–45, 44f
tool joints, 52, 57, 86, 180, 181
top bushing, 79
torque
backing off and, 79
differential sticking and, 87
during a fishing operation, 75
in a positive-displacement motor, 38–39, 39f
in a washover, 82
reactive, 41–42
total depth, reaching, 4
tour, 148
trajectory, 4, 6, 30, 53
traveling slips, 186
traveling-cylinder diagram, 15
trip, 20, 145, 163–165
trip gas, 127
trip margin, 115
trip out
controlling a well kick during, 145
differential sticking and, 88
keyseats and, 86
kick following, 133
reduction in BHP and, 131
removing the magnetic single-shot before, 20
well kicks during, 163–165
trip tank, 116, 116f
triplex mud pump, 117, 117f
true north, 10
true readings, 22
true vertical depth (TVD), 8, 30, 106, 107. See also depth.
tubing, 164
tungsten carbide, 69, 81
tungsten carbide inserts, 69
TVD. See true vertical depth (TVD).
twistoffs, 60, 60f, 66, 69–70
unconsolidated formations, 122
underbalanced drilling (UBD), 108
underbalanced pressure, 108
underbalanced well, 133
undergauge hole, 34, 62, 62f, 79
underground blowout, 102, 121, 161, 188
unplanned deviation, 9
up-dip, 54, 55f
U-tube, 148, 148f
vent lines, 167, 168
vertical inclination, 17, 17f
vertical section, 8
vertical slab plot, 14, 14f
viscosity, adjusting in drilling fluid, 56
volumetric displacement correction, 182–183, 183f
volumetric methods (well control), 115, 175f
vuggy formation, 188
wait-and-weight method, 156–159, 156f
wall hook, 74, 75f
wall sticking, 65
wall-stuck pipes. See differential sticking.
wandering bit, 54
washouts, 60, 63, 63f
washover pipe, 79, 81, 82f. See also casing.
washer string, 79, 80f
washovers, 79–82, 88
weight on bit (WOB), 39, 48. See also bit.
well control. See also blowouts.
bullhead kill method, 160, 161f
concurrent method, 159
driller's method, 149–155
dynamic kill method, 161–162
ew with drill pipe off the bottom, 163–165
killing an onshore kick, 144–145
lost circulation and, 188–189
lubricate-and-bleed method, 163–164
mistakes in, 165–166
momentum kill method, 162
offshore drilling, 167–169
overview of, 143
reverse circulation, 164
slow pump rates for, 148
snubbing operations, 186–189
special problems in, 170–189
using drill pipe as a BHP gauge, 145–147, 146f
wait-and-weight method, 156–159, 156f
well flow, 144, 165
well patterns and applications, 4–6, 5f, 7f, 32
well plan, 8–15, 9f, 10f, 11f–14f, 32
well survey, 31, 31f
well types, 4, 5f, 8, 9f
wellbore, 1
wellhead, 139
whipstocks, 34, 35f
wild wells, 4
wireline, 20, 90–92
wireline grab, 90, 90f
wireline spear, 90, 90f
WOB. See weight on bit (WOB).
workover, 164
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