ROTARY DRILLING

Open-Hole Fishing

Fourth Edition

UNIT III • LESSON 2

ROTARY DRILLING SERIES

Contents

About the Authors

Jerry Fisher has 36 years experience working with fishing and re-entry products, of which the past 12 years have been with Weatherford International, Ltd. Jerry is currently serving as the Global General Manager for Fishing Services, based in Houston, Texas. His past positions include the Middle East/North Africa Regional Fishing and Re-Entry Product Line Manager, based in Dubai, UAE; the Operations Manager, Fishing Re-Entry Product Line, based in Aberdeen, UK; and the Fishing Tool Supervisor overseeing the Fishing & Re-Entry Product Line throughout the United States, North Sea, Continental Europe, and West Africa. Jerry has a vast amount of experience in all types of fishing operations including open-hole, cased-hole, milling, cutting, well abandonment, slot recovery, casing milling, and casing exits.

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Arthur holds a B.S. in Manufacturing Systems-Engineering Technology from the University of Houston and is a member of the SPE and ASM.

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 Systeme International (SI) d'Unites. Conference participants based the SI system on the metric system and designed it as an international standard of measurement.

The Rotary Drilling 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

Quantity or Property	English Units	Multiply English Units By	To Obtain These SI Units
Length, depth, or height	inches (in.)	25.4	millimetres (mm)
		2.54	centimetres (cm)
	feet (ft)	0.3048	metres (m)
	yards (yd)	0.9144	metres (m)
	miles (mi)	1609.344	metres (m)
		1.61	kilometres (km)
Hole and pipe diameters, bit size	inches (in.)	25.4	millimetres (mm)
Drilling rate	feet per hour (ft/h)	0.3048	metres per hour (m/h)
Weight on bit	pounds (lb)	0.445	decanewtons (dN)
Nozzle size	32nds of an inch	0.8	millimetres (mm)
Volume	barrels (bbl)	0.159	cubic metres (m^3)
		159	litres (L)
	gallons per stroke (gal/stroke)	0.00379	cubic metres per stroke (m^3/stroke)
	ounces (oz)	29.57	millilitres (mL)
	cubic inches ($in.^3$)	16.387	cubic centimetres (cm^3)
	cubic feet (ft^3)	28.3169	litres (L)
		0.0283	cubic metres (m^3)
	quarts (qt)	0.9464	litres (L)
	gallons (gal)	3.7854	litres (L)
	gallons (gal)	0.00379	cubic metres (m^3)
	pounds per barrel (lb/bbl)	2.895	kilograms per cubic metre (kg/m^3)
	barrels per ton (bbl/tn)	0.175	cubic metres per tonne (m^3/t)
Pump output and flow rate	gallons per minute (gpm)	0.00379	cubic metres per minute (m^3/min)
	gallons per hour (gph)	0.00379	cubic metres per hour (m^3/h)
	barrels per stroke (bbl/stroke)	0.159	cubic metres per stroke (m^3/stroke)
	barrels per minute (bbl/min)	0.159	cubic metres per minute (m^3/min)
Pressure	pounds per square inch (psi)	6.895	kilopascals (kPa)
		0.006895	megapascals (MPa)
Temperature	degrees Fahrenheit (°F)	$\frac{°F - 32}{1.8}$	degrees Celsius (°C)
Mass (weight)	ounces (oz)	28.35	grams (g)
	pounds (lb)	453.59	grams (g)
		0.4536	kilograms (kg)
	tons (tn)	0.9072	tonnes (t)
	pounds per foot (lb/ft)	1.488	kilograms per metre (kg/m)
Mud weight	pounds per gallon (ppg)	119.82	kilograms per cubic metre (kg/m^3)
	pounds per cubic foot (lb/ft^3)	16.0	kilograms per cubic metre (kg/m^3)
Pressure gradient	pounds per square inch per foot (psi/ft)	22.621	kilopascals per metre (kPa/m)
Funnel viscosity	seconds per quart (s/qt)	1.057	seconds per litre (s/L)
Yield point	pounds per 100 square feet (lb/100 ft^2)	0.48	pascals (Pa)
Gel strength	pounds per 100 square feet (lb/100 ft^2)	0.48	pascals (Pa)
Filter cake thickness	32nds of an inch	0.8	millimetres (mm)
Power	horsepower (hp)	0.75	kilowatts (kW)
Area	square inches ($in.^2$)	6.45	square centimetres (cm^2)
	square feet (ft^2)	0.0929	square metres (m^2)
	square yards (yd^2)	0.8361	square metres (m^2)
	square miles (mi^2)	2.59	square kilometres (km^2)
	acre (ac)	0.40	hectare (ha)
Drilling line wear	ton-miles (tn•mi)	14.317	megajoules (MJ)
		1.459	tonne-kilometres (t•km)
Torque	foot-pounds (ft•lb)	1.3558	newton metres (N•m)

Causes of Fishing Jobs

In this chapter:

- Types of large and small fish
- Common causes of fishing jobs
- Mechanical sticking, differential sticking, and sheared drill string
- Elements that can comprise junk in the hole

Fishing can be divided into two broad categories: open-hole and cased-hole. A major difference between the two is timing: open-hole fishing is done as the well is being drilled, whereas cased-hole fishing is performed during production or well workover. Fishing techniques and types of equipment used also vary between the two. This book describes the basic techniques and tools used in open-hole fishing—that is, retrieving fish from a hole that is being drilled but is not yet cased.

Just as there are many types of fish, there are many ways that equipment can become lost or stuck in the hole. Each fishing job is unique; the tools and techniques needed to fish a string of stuck pipe from one well may not work at another well or under other conditions at the same well.

The largest type of fish is a segment of the drill string that has become stuck, has broken off, or has been purposely disconnected. Comparatively small fish, known as *junk*, can also result from drill string failure. Slivers of metal may come loose when the drill string parts. Metal fragments also are produced during the process of *milling* a larger fish to aid in its recovery. And junk from uphole may stick the drill string by jamming between the drill pipe or collars and the hole wall.

Preparing for a Fishing Job

In this chapter:

- Questions an operator asks to prepare for a fishing job
- How to determine depth of broken drill string
- Necessary hole and fish conditions

When it becomes necessary to fish drilling equipment out of an uncased hole, the experienced operator finds out as much as possible about the situation before taking action. The first step is usually to ask for the most recent well survey, a map of the borehole that shows where the bit deviated from vertical during drilling.

The operator will then attempt to answer a number of questions, including the following:

- What is to be fished out of the hole?
- Is the fish stuck, or is it resting freely?
- If stuck, what is causing it to stick?
- What is the condition of the hole?
- What is the size and condition of the fish?
- Is it possible to screw into the threads on the fish? If not, could fishing tools be run outside the fish, or must they be run inside it?
- Could other tools be run through the fishing assembly that is to be used?
- Are there at least two ways to disengage from the fish if it cannot be freed?

Fishing Out a Twistoff

In this chapter:

- The variety of mills used to dress the top of fish
- Scenarios for mill tool usage
- Importance of speed and weight in milling
- Procedure for engaging the fish

If part of the drill string has broken off in an open hole and is not stuck, the fishing job consists mainly of locating and engaging the top of the fish with an appropriate fishing tool.

In many cases the operator will find that the top of the broken-off pipe is badly split and twisted. Most fishing techniques require a section of straight, undamaged pipe to make a firm catch. The damaged metal must be removed to give the fish a more acceptable shape.

Fishing for Stuck Pipe

In this chapter:

- Methods of freeing a mechanically stuck pipe: jarring, finding the stuck point, backing off, washing over, drilling out, and cutting pipe
- Steps in freeing pipe from a keyseat
- Methods of freeing wall-stuck pipe

As mentioned earlier, there are two main ways that pipe can become stuck in the hole: mechanical sticking by solid materials and differential sticking by fluid pressure. Keyseating is a particular type of mechanical sticking that happens when the pipe becomes stuck during a trip. Although differential sticking is the most common reason for stuck pipe, fishing techniques are somewhat limited for recovering differentially stuck, or wall-stuck, pipe. Emphasis is therefore placed on preventing wall sticking from the start.

Freeing Mechanically Stuck Pipe

After a fish has been caught in the overshot, the usual procedure is to circulate out the settled cuttings without rotation. If circulation cannot be fully established and the fish cannot be pulled, the fish is almost certainly stuck mechanically in the hole.

Other Fishing Jobs

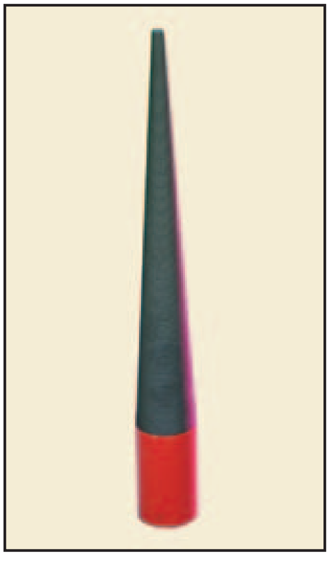
In this chapter:

- The process of recovering drill collars
- Considerations for fishing pipe sheared on an offshore rig
- Steps for fishing for stuck wireline and wireline tools
- Tools and methods for junk removal

Recovering Drill Collars

When a drill collar separates, the break usually occurs at a connection: the pin breaks off in the box, or the box breaks off and comes out with the top part of the string. The remaining collars can usually be fished out with a standard overshot and jar assembly. However, if the diameter of the drill collar is very close to that of the wellbore, as in a *packed-hole assembly*, an overshot may not have enough clearance to go over the collars. The outside diameter of the fish must be milled over to create a fishing neck that a standard-size overshot can engage.

As a last resort a *taper tap* can be used to screw into the inside diameter of the drill collar (fig. 50). The taper tap is nonreleasing, so it is used only when an overshot cannot be run. The tap is lowered into the collar bore and slowly rotated to cut its own threads as it engages the fish. Some taps have open tips, allowing limited circulation for cleaning off the top of the fish; others have small side jets that move the point of the taper tap about to help locate the top of the fish.



Courtesy of Weatherford International

Figure 50. Taper tap

The Economics of Fishing

In this chapter:

- How to calculate the number of days a fishing job should be allowed to continue
- The role of specialized fishing service companies
- The significance and limitations of fishing insurance

Some fishing jobs can go on for months before the fish is retrieved. After a certain period, however, the cost of fishing operations and lost drilling time become prohibitive. Generally, once these costs reach above half the cost of sidetracking and redrilling, fishing should be abandoned. In some cases the operator will opt to sidetrack immediately, without even attempting a fishing operation.

One way to calculate the number of days that should be allowed for fishing uses the following equation:

$$D = \frac{V + Cs}{R + Cd}$$

where

D = number of days to be allowed for fishing;
V = replacement value of fish;
Cs = estimated cost of sidetracking;
R = daily cost of fishing tool rental and services; and
Cd = daily rig operating cost.

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