The Oil & Gas Industry
A Nontechnical Guide

Contents

Preface

This book provides a nontechnical overview of what is commonly referred to as the petroleum industry, focusing on oil and natural gas, as well as their derivative products. My goal has been to create an engaging and accessible introduction to this critically important global industry to help those without a technical background who are either new to the industry or simply interested in how it operates.

This book guides the reader through the series of typical decisions made, actions taken, and equipment and processes used to bring petroleum products and natural gas to world markets. I have tried to present information about these various activities in broad but also clear and accurate terms. However, I have not attempted to describe every operational facet or technical aspect; this level of detail is available from a variety of other sources, a number of which are listed in appendix B.

The word "petroleum" is based on the Latin *petrus* (rock) and *oleum* (oil). Petroleum can range in color from nearly colorless to jet-black. It can be thinner than water or thicker than molasses, and its density can vary from that of a light gas to that of a heavy asphalt. For the purposes of this book, the term *petroleum* is used to collectively describe oil and natural gas, whereas the *petroleum industry* includes the various entities that perform the range of activities noted in the bulleted list below, as well as those that support those activities.

Chapter 1 describes the geologic processes and structures related to the formation of both crude oil and natural gas within the earth, as well as its movement (migration) that results in the creation of commercially exploitable accumulations. Chapters 2 and 3 then focus individually on oil and gas, respectively, providing basic information about their composition, the location of major oil and gas resources around the world, the range of products created from oil and gas, and current patterns of, as well as future projections for, production and use.

Chapters 4 through 12 address petroleum industry operations:

- Searching for and evaluating petroleum resources
- Drilling and completing wells to tap promising formations (onshore and offshore)
- Managing oil and gas production
- Transporting oil
- Transporting natural gas in both gaseous form (by pipeline) and in liquefied form
- Converting oil and gas into various products

Chapters 13 through 15 address several business-related issues: the structure of the industry, the dynamics of petroleum trading, and the challenges facing the industry. Finally, three appendices provide a listing of terms, abbreviations, and acronyms used in the book; suggested further reading; and organizations that can provide further information on many of the topics covered in this book.

I hope this book helps the reader understand the petroleum industry and makes clear the ingenuity and skill of its millions of professionals worldwide.

1 Origins of Oil and Gas

A discussion of the operations of the petroleum industry—including production and the extensive slate of useful products—must begin with a review of the origins of the raw material comprising the foundation of the industry's value chain. In the case of petroleum, the origins of crude oil and natural gas can be traced back millions—in fact, tens of millions—of years ago, to the seabed of ancient oceans.

A Brief Overview

For hydrocarbons to accumulate, three conditions must be met. First, a sedimentary basin must be created—the result of movement of the earth's crust, which creates large depressions into which sediments from surrounding elevated areas are transported over time.

Second, the sediments laid down in such basins must contain a high level of organic material. This organic-rich matter becomes part of the sedimentary material to create what is called *source rock*.

Third, over millions of years, the effects of elevated temperature and pressure must be sufficient to convert the material in the source rock into oil and gas. *Maturity* describes the degree to which petroleum generation has occurred. Heavy, thick oil is considered immature, having been generated at relatively low temperature. Mature oil—lighter or less viscous—forms at higher temperature.

In an important subsequent process called *migration*, the hydrocarbons must move out of the source rock through cracks, faults, and fissures and into porous and permeable *reservoir rock*. Finally, that reservoir rock must be configured (as a result of prior geologic activity) in a

Table 2–2. Nations with largest estimated oil reserves, 2012

Country[a]	Estimated proved oil reserves as of January 1, 2012,[b] billion barrels	Producing oil wells as of December 31, 2010[c]	Estimated oil production in 2011, million b/d
Saudi Arabia	264.52	2,895	9.00
Venezuela	211.17	14,651	2.51
Canada	173.62	62,519	2.86
Iran	151.17	2,074	3.58
Iraq	143.10	1,526	2.48
Kuwait	101.50	1,286	2.18
United Arab Emirates[d]	97.80	1,458	2.50
Russia	60.00	107,476	10.32
Libya	44.10	2,060	0.44
Nigeria	37.20	2,068	2.18
Kazakhstan	30.00	1,256	1.60
Qatar	25.38	513	0.81
United States	20.68	373,648	5.60
China	20.35	71,552	4.09
Brazil[e]	13.99	11,797	2.08
Algeria	12.20	2,014	1.27
Mexico	10.16	7,476	2.54
Angola	9.50	1,321	1.64
Azerbaijan	7.00	62	0.93
Ecuador	7.21	3,447	0.50
India	8.93	3,719	0.78
Norway	5.32	812	1.74
Oman	5.50	2,286	0.89
Neutral Zone (Iraq/Saudi Arabia)	5.00	761	0.59
Sudan[f]	5.00	42	0.47

Source: Oil & Gas Journal survey data as of Jan. 1, 2012.

[a] Only nations with at least 5.0 billion barrels of estimated reserves are shown.

[b] All reserves are reported as proved reserves recoverable with current technology and prices except those for Russia; that figure includes proved plus some probable. Reserves data for Canada includes tar sands.

[c] Well count does not include shut-in, injection, or service wells.

[d] Abu Dhabi has 94.3% of the reserves in the seven United Arab Emirates.

[e] Brazil may have 50–100 billion barrels of additional reserves in presalt offshore formations.

[f] South Sudan gained independence from Sudan on July 9, 2011; no separate data for South Sudan were available for presentation in this book.

Table 3–2. Estimated shale gas technically recoverable resources for selected basins in 32 countries

Region/country	Technically recoverable shale gas resources, tcf
Europe:	
France	180
Germany	8
Netherlands	17
Norway	83
United Kingdom	20
Denmark	23
Sweden	41
Poland	187
Turkey	15
Ukraine	42
Lithuania	4
Other[a]	19
North America:	
United States	862
Canada	388
Mexico	681
Asia:	
China	1,275
India	63
Pakistan	51
Australia	396
Africa:	
South Africa	485
Libya	290
Tunisia	18
Algeria	231
Morocco	11
Western Sahara	7
South America:	
Venezuela	11
Colombia	19
Argentina	774
Brazil	226
Chile	64
Uruguay	21
Paraguay	62
Bolivia	48
Total	6,622

Source: EIA

[a] Includes Romania, Hungary, and Bulgaria.

After all legal and environmental issues are settled, the crew goes about preparing the drill site. For an onshore site, this entails the following steps:

- The land is cleared and leveled, and access roads are built if needed.
- A water well is drilled if necessary to provide the significant volumes of water used in oil and gas drilling operations.
- A reserve pit is dug and lined with plastic, to hold rock cuttings and drilling mud generated during the drilling process. In environmentally sensitive areas, the cuttings and mud are trucked off-site instead of being placed in the pit.

As described in chapter 6, for an offshore site, the drill site is on the seabed. There is no site preparation in the conventional sense.

Once the land has been prepared, the crew digs several holes to make way for the rig and the main hole (fig. 5–1). A rectangular pit, called a *cellar*, is dug around the point where drilling will take place. The cellar provides a workspace around the hole and room for auxiliary equipment that will be located below the floor of the main drilling platform.

The crew then drills the main hole, often with a small drill truck rather than the main rig. The first part of the hole is larger in diameter than, and not as deep as, the main portion will be and is lined with a large-diameter conductor pipe. Other holes are dug off to the side to temporarily store equipment. After these holes are finished, the rig equipment can be trucked in and set up. If necessary, equipment may be brought to the site by helicopter or barge.

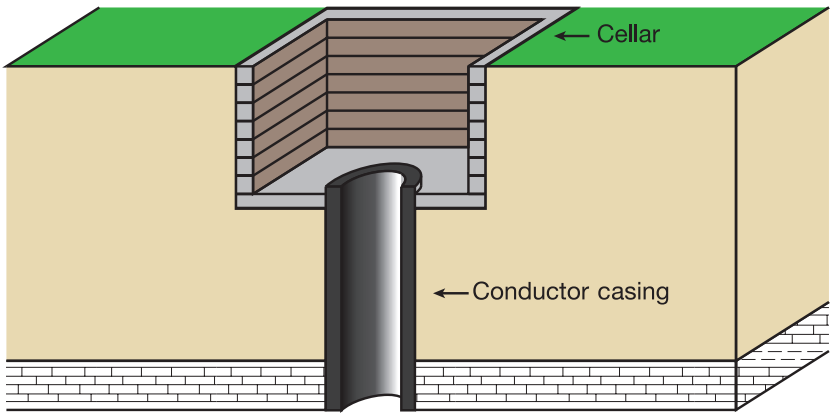

Fig. 5–1. Cellar and conductor casing (*Source:* Hyne, N. J.)