Les has a long history of oilfield experience. He literally grew up in the oilfield, specifically, the Texas Panhandle Field. Les grew up in a company camp, Phillips, Texas, leaving little doubt about the company that employed his father. His got his first job working as a roustabout at the ripe old age of 16.

Les attended Texas Tech University in Lubbock, Texas where he earned a BS degree in Chemical Engineering in 1972. Upon graduation, he began his professional career as a Petroleum Engineer, Junior Grade, for Amoco Production Company. This was followed several years later by reservoir engineering and operations management jobs for several independent operators in Midland, Texas. His work involved wells all over the United States and included drilling underbalanced horizontal wells in the Austin Chalk in the late-1980s.

In 1990, Les joined a well control company in Houston and worked in a number of locations around the world including Kuwait following Operation Desert Storm. His work included environmental engineering, drilling, completion, workover and abandonment operations using a variety of tools and platforms including coiled tubing, snubbing, conventional drilling rigs and workover units. Later, Les joined a large service provider specializing in well control, coiled tubing, snubbing and pumping services. He is the co-author of four patents, two dealing with coiled tubing and two with snubbing.

Les has written over 40 technical papers and articles including a column on drilling operations for a major oilfield publication for five years. He is a member of IADC, SPE, AIChE, ASME, AADE and has been a licensed professional engineer in Texas since 1978. He lives in Houston with his wife. His three children are grown, and he has three grandchildren and one great-grand. He is currently working as a consulting drilling operations manager and engineer in the greater Houston area.
Coiled Tubing Operations

by

Les Skinner, P.E.
About Coiled Tubing Operations

This book is designed to provide accurate and authoritative information in regard to the subject matter covered, and for the general information and education of the reader. Although the author and publisher believe the information presented is accurate as of the date of publication, each reader is responsible for his own reliance, reasonable or otherwise, on the information presented. If professional engineering expertise is required, the services of a competent individual or firm should be sought. Neither the author nor the publisher warrant or guarantee that application of any theory, concept, method, or action described in this book will lead to the result desired by the reader.

This book was prepared under the auspices of the IADC Technical Publications Committee as part of the IADC Drilling Series. The IADC Drilling Series is a collection of books covering key topics that the drilling engineer needs to know. For more information, go to www.IADC.org/technical-publications-committee/.

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David R. Skinner
(January 16, 1946 - January 16, 2014)

This book is dedicated to the memory of Dave Skinner: author, teacher, mentor, fellow engineer and brother.

Another oilfield hand goes home.

See you on the next well, bro.
Acknowledgments

Rarely are books the effort of a single author or even several authors. Other individuals and groups are always involved, if the book is properly written, carefully edited and vigorously peer reviewed. It is the others I wish to thank and acknowledge here.

First, for his leadership as the chair of our rowdy group, thanks to Dr. Leon Robinson, along with vice chairs, team leads and other executives, including Nace Peard, Gary Young, Dr. Fred Growcock and Bob Line, all of whom had a hand in approving the outline for this book, reviewing parts of it and generally keeping us pointed in the same direction. Many others reviewed the material, including Juan Garcia, Mark Ramsey, Sam Bridges, Mark Morgan, Bill Rehm, Dr. Arash Haghshenas, Charlie Stocker, Jerrod Rice, Ron Sweatman, Bob Radke, Jerry Haston and Mary Dimataris. Their suggestions have done much to improve the quality and consistency of the book.

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Houston, Texas

November 2015
Foreword

The mission of the IADC Technical Publications Committee (TPC) is to publish a comprehensive, practical, and readily understandable series of peer-reviewed books on the petroleum drilling industry, in order to educate and guide industry personnel at all levels. Authors present outlines of various drilling topics to the committee for proposed books. The TPC reviews the outline for content and accuracy and evaluates the author’s credibility. Clarity of writing is also a requirement before the book is accepted as part of this drilling series.

Many experts understand their particular field of technology, but are unable to explain it in simple, coherent terms. A true understanding means that the complex subjects can be explained in terms that any intelligent person can understand. The committee is searching for those kind of experts. After approval and usually many suggestions for additions/deletions/changes by the TPC, the author or authors write the book and present it for peer-review. The peer review teams consist of recognized experts in the particular topic of the book and also people who are not experts in this field but are knowledgeable about drilling.

IADC is the perfect sponsor and publisher for this series of books. Their members are all focused on drilling operations and IADC has the opportunity to provide its members with the latest technology. These books can cover history of the material, common and standard practices that have been field-tested, and the newest developments in each subject. IADC is interested in providing their membership with this valuable technology. The TPC has set very high standards for the authors of these books.

Authors must have many years of hands-on experience in the subject matter, as well as be good writers and able to express themselves clearly. They write not only for the readers to understand the material, but also to avoid any misunderstanding. Several professionals have presented requests to be an author of an IADC TPC book and submitted outlines for book but have failed to pass this preliminary screening.

Les Skinner, the author of “Coiled Tubing Operations”, has not only met all of these stringent requirements, but brings a depth of knowledge about the entire drilling process. He was involved with coiled tubing early in his career when coiled tubing was initially introduced into the oil patch. Initially, coiled tubing was used mostly as a remediation tool. Small-diameter tubing could be coiled and used for workovers or for cleaning out problems inside of drill pipe. The application has grown significantly since then. Now large diameter tubing can be coiled and wells drilled with it. The acceptance into the oil patch has been slow but steady for many years. This book starts with the first coiled tubing application and expertly follows the development through the years to where it is today. The author does a great job of describing the past, the present, and by extension, the future of coiled tubing.

Leon Robinson, PhD
Chairman of the IADC Technical Publications Committee
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Coiled tubing is a type of pipe that is transported, deployed from and recovered on a reel or spool. For the intent of this handbook, coiled tubing is used in a well that is intended to produce oil, gas or water. Thus, it is retrievable, although some coiled tubing has been cemented in wells and used as “spooled casing,” especially when in a tubingless completion where the well produces up the “spooled casing.”

Coiled tubing differs from jointed, or “stick,” pipe because it is continuous without connections along the length of the pipe body. So, as it is run into a well and pulled back out, the pipe is coiled onto a spool much like fishing line is stored on a reel. This reduces the space required for managing the pipe at the wellsite, a particularly important issue for small offshore production platforms. It also allows the pipe to be run and retrieved faster than jointed pipe since there is no time required for screwing joints of pipe together. Imagine how long it would take to tie, say, 10-ft pieces of fishing line together to make up a long fishing line, then taking them apart at the end of the day and storing them in a long box in the boat!

Other components of a coiled tubing unit include a set of blowout preventers with rams designed to catch and hold the coiled tubing, cut the pipe and seal the annulus between the wellbore and the coiled tubing. A device is needed to run the coiled tubing into the well and to recover it – commonly called an injector. A guide to keep the pipe from buckling or kinking just before it goes into the well is often required. This is called a guide arch or goose neck. Once the coiled tubing reaches the reel it runs through a level wind device that lays the pipe in smooth layers on the spool, again like a fishing reel. A control cabin is provided so the operator can manage the equipment from a clear vantage point. The entire assembly is powered by either pressured hydraulic fluid or electric motors. Other equipment can include pumps, pits, downhole motors and various tools, a power supply and other similar equipment. Each of these is discussed later.

Historical development

Flexible hoses of various types have been run off and stored on spools for decades. Water hoses on reels were used for many years to fight fires. Water was transported to power large monitors in surface mining operations in the late 1700s and throughout the 1800s. These were generally rolled up on reels, spools or “thimbles,” making them easy to transport and simple to deploy and retrieve.

Modern spooled pipe, however, owes its beginning to an ambitious program to supply fuel to Allied troops and equipment across the English Channel following the invasion of Europe in June, 1944 — Operation PLUTO (Pipe Line Under The Ocean). The English Channel is known for unpredictable weather, with storms impacting shipping in a matter of hours. Allied planners did not anticipate that ports along the northern French coast would be available after the invasion. The menace of German U-boats made the risk of shipping fuel in tankers from England to the invasion sites untenable. Also, conventional subsea pipeline construction required individual pipe joints to be welded together, sealed and coated, deployed from a slow-moving lay barge or ship. It would take months to build a single pipeline across the English Channel during which time the operation would likely be under bombardment by enemy aircraft. So, another way had to be developed. The outcome was PLUTO.

Two types of underwater pipelines were developed starting in 1941. The first was, essentially, a hollow undersea communications cable. The original core of this pipe was a 2-in. diameter lead pipe surrounded by a woven protective sheath of steel tape, wire, woven cloth and rubber with a coal tar coating. The so-called HAIS pipe (after the inventor’s initials (Harley), his employer (Anglo/Iranian Oil) and the developer (Siemens), was very flexible but also somewhat fragile. The new 3-in. lead inner core could be flattened easily during deployment and end connection rendering the pipeline useless. Further, as one historian put it, to secure enough lead to construct all the undersea pipelines necessary, the lead roofs of every church in England would have to be removed, melted down and recast into pipe. Obviously, this did not sit well with the faithful.

The War Ministry then approached Iraq Petroleum and Burmah Oil, two British oil companies, to develop tough, flexible, special-metallurgy pipe that could withstand the