INTERNATIONAL MOLYBDENUM ASSOCIATION
THE VOICE OF THE MOLYBDENUM INDUSTRY

Wireline for downhole tools

Wireline is cable used to lower oil- and gas-well tools and measuring equipment downhole. Wireline must be strong, dependable and resistant to the increasingly corrosive conditions encountered in today's deeper wells. Molybdenum imparts the required corrosion resistance to the stainless steel and nickel alloys used in this application.

Drilling for oil and gas is not as simple a task as might be imagined. Boring the hole is only the beginning of a producing well. When the hole is complete, and at many points during boring, drillers must install components that help to control the flow of oil once production starts. They must do it in a manner analogous to building a ship-in-a-bottle, except that the bottle's neck length is measured in kilometers instead of millimeters.

In addition to these production-related needs, oil and gas geologists and drill-rig personnel need to know the nature and characteristics of the geological formations they encounter as they drill. To obtain this vital information, they stop drilling periodically and lower measuring, or 'logging', tools into the well. These tools measure the chemical and physical properties of the downhole rock, and capture the data for evaluation. Logging tools are packed with sophisticated and very expensive analytical equipment; some can even reach out and grab small samples of surrounding rock.

These production components and logging instruments are lowered into place using wireline, special cabling designed for the purpose and made from molybdenum-containing alloys that can bear the load and withstand the high temperatures and corrosive environments of deep wells.

The wireline

Drillers use two kinds of wireline: 'slick' line and 'electric' wireline. Slick line is typically 1.83–4.06-mm solid wire, used to handle valves and other essential production equipment that controls the flow of oil once the well is producing. Operators also use it to retrieve downhole equipment that is no longer needed, and to fish out broken components that block the well bore. Electric wireline is a more complex product, consisting of a braided-wire sheath that encloses insulated signal wires. Electric wireline lowers instruments into position for well-logging tests. The braided sheath supports the weight of the instruments and protects the signal wires, while the signal wires transmit data from the logging tool to the surface.

The function and importance of electric wireline cannot be overstated. Modern logging equipment employs a variety of active and passive instruments to extract information about the rock formations surrounding the bore. Simple tools such as calipers and electrical probes provide information about the integrity of the rock, the identity of contained fluids and the fluids' corrosion potential. Highly sophisticated tools that probe the surrounding rock's response to sonic waves and neutrons provide data about porosity and rock composition. Gamma ray detectors monitor the natural radiation emitted by the rock, allowing geophysicists to differentiate sandstone from shale. The data transmitted by the instruments paint an accurate and detailed picture of what is present in the rock along the entire length of the borehole, helping geophysicists determine where the well is most likely to yield oil and gas. Wireline is a key part of the technology needed to make good drilling decisions.

Logging tools that are ready to be lowered into the well with wireline. © Downunderphoto–Fotolia.com

Wireline performance requirements

Wireline integrity is critical to the success of drilling and operating a well, and molybdenum helps to ensure wireline performance. Both slick line and electric wireline must be very strong to support the weight of both the instrument or tool and of the wireline itself. The weight of the wireline can be significantly greater than the weight of the instruments and tools, because of the need to lower them to great depth. In many regions of the world, the easily extracted oil and gas, located relatively near the surface, have already been exploited. Newer wells are often drilled thousands of meters deep to find commercially viable pay zones. Wireline with uniform mechanical and physical properties is required in corresponding lengths.

Wireline must also tolerate the high temperatures, high pressures, and hostile chemicals such as chlorides and hydrogen sulphide that characterize the downhole ›

environment. These extreme conditions can promote catastrophic failure, so wireline must be highly corrosion resistant as well as strong.

Wireline materials utilize molybdenum

Molybdenum-containing stainless steels and nickel-chromium alloys are the materials of choice for wireline. A variety of grades and alloys offer a range of performance and cost. The alloy choice depends on the strength and corrosion-resistance requirements of each individual well. Type 316 stainless steel is the basic material for sweet wells with moderate conditions. In medium sour wells without H_2S, the stronger 2205 duplex stainless steel is a candidate. As depth increases, temperatures increase and the conditions become highly corrosive; especially for sour wells with H_2S, catastrophic failure becomes likely in many materials. Only the highly molybdenum-alloyed super austenitic stainless steels or nickel-based alloys will do the job in this case. These alloys are effective because they can be cold worked to high strength while retaining resistance to hydrogen. At the same time, they are highly corrosion-resistant thanks to their chromium and molybdenum content.

Nominal compositions of some wireline alloys

Alloy	% Mo	% Cr	% Ni	% Cu	% C	% N	% Co
S31600	2–3	17	10.5	–	0.05	–	–
S32205	2.5–3.5	22	5	–	<0.02	0.17	–
N08028	3.5	27	27	1.2	<0.015	0.05	–
N08936	5.4	27	34	–	<0.02	0.4	–
N08031	6.5	27	31	1.2	<0.015	0.2	–
N08926	6.5	20	25	0.9	<0.02	0.2	–
S31277	6.5–8	20.5	27	–	<0.02	0.3	–
R30035	9–10.5	20	35	–	<0.02	–	35

The crew is preparing to lower wireline equipment downhole for logging on an offshore oil rig.
© Ingvar Tjostheim/shutterstock.com

According to a 2012 market study, about 50% of wireline is Type 316 stainless steel, some 30% is duplex stainless steel and 10% is the nickel-based alloy 28 with the rest being the other grades. The annual demand for slick lines and electric lines is some 2,500 metric tons and the average molybdenum content is estimated to be 3.4%.

Summary

Oil and gas are essential to our modern way of life. A seemingly simple product – wireline – is an important part of oil and gas production technology. Molybdenum-containing alloys are indispensible materials for wireline, thanks to their excellent strength and corrosion resistance. They enable us to exploit oil and gas reserves that might otherwise be inaccessible. (Frank Smith)