Moly is a Jack of all trades

At the ends of the earth, strange machines patrol the oceans in search of oil deposits to drill for. Meanwhile, their cousins stand tall in some of the world's gustiest seas, installing or maintaining offshore wind turbines. Both of these highly specialized vessels, lifted up by jackup legs, brave extreme conditions on the sea to help meet our global energy demand. But constant exposure to high winds and enormous waves means 'jackups' must be made of strong materials. Molybdenum-containing steel allows these special machines to stand up to the forces of nature, while ensuring the safety of the people who work and live onboard them.

A jackup rig is a most unique sea creature; it is a self-elevating, mobile platform with movable legs. With its legs raised high above the water, it is reminiscent of something from a science-fiction film set. Despite the futuristic appearance, jackup rigs have actually been around since the 1950s, when the aptly named 'Rig No 1' was manufactured in the United States. Today, there are more than 500 rigs in operation around the world.

Jackup rigs used to be deployed almost exclusively for oil and gas exploration and well drilling. They are easily relocated, and as a result, are much less expensive than fixed offshore platforms, which are constructed on already explored wells. Jackup rigs are also cheaper to operate than drill ships, which are still used for deeper waters. However, in the last few years, the jackup mechanism has increasingly been utilized in the renewable energy sector for wind turbine installation, repair and maintenance vessels. These vessels offer a stable work bench for wind turbine installation by lifting a platform up over the roiling waves. Current lifting cycles are faster than once a day – a rapid increase over installation times just a decade ago. This increase in efficiency means that an 80-turbine wind park can now be constructed within three months instead of a couple of years, dramatically reducing the cost of a new wind energy project.

The Pacific Osprey jackup vessel is lifted off the sea and remains stable and disconnected from the waves below for the installation of a wind turbine. © Swire Blue Ocean

Standing on the bottom of the ocean

While a jackup vessel is on its journey, its legs are raised high above the water. When it arrives at the desired position, the legs of the rig are lowered (or 'jacked') into the water, and driven down onto the sea floor. The weight of both the barge and additional ballast water drive the legs into the seabed. When the legs are safely in place, the entire floatable platform is 'jacked up' off the surface of the water, isolating the platform from the motion of the waves and tides underneath and keeping it stable.

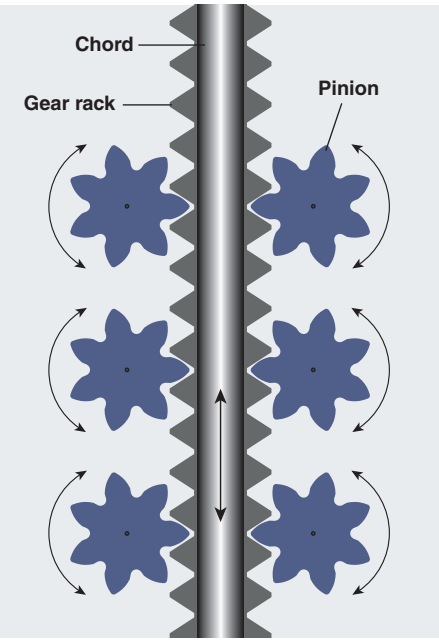
Traditionally, jackups are used in shallower waters, which are less than 120 meters deep. However, the legs of jackups vary in length depending on their target market. For oil and gas drilling they are increasingly made longer, now allowing for operation in waters as deep as 150 meters. For wind applications they tend to be shorter ›

as the majority of turbines are installed in water depths of 40 meters or less.

Oil and gas rigs are often platforms which are towed by boat to their destination. They may remain at the same spot for months or even a year. Wind installation vessels, on the other hand, look more like a boat. Typically they need to change position daily and are therefore self-propelled.

By the skin of their teeth

Most rigs have a rack and pinion jacking system, where the pinion gears drive gear bars, called racks, which form the corners of each of the legs of the rig. The protruding 'teeth' of the rack connect with the pinion gear, which incrementally pushes the leg either up or down. At any given time, the weight of the platform combined with the stresses from this driving action impose a concentrated load on just a couple of teeth in the rack. This requires a very strong steel, typically a 690 steel with a minimum yield strength of 690 MPa, containing up to 0.6% molybdenum.



The corners of a leg are made of two heavy-walled chords welded to the gear rack. Motors drive the pinions that move the gear rack up and down, which lowers and raises the vessel.

Inspecting the high-strength steel racks and their 'teeth' on the legs of a jackup vessel. © DIRA Group

The thickness of the rack depends on the length of the leg, the load of the platform and the frequency of raising and lowering the legs. The rack is at least 100 millimeters, and for the newest wind turbine installation vessels, up to 250 millimeters thick. Only a few companies worldwide can produce and fabricate such heavy plates and sections of high-strength steel.

To reach the necessary yield strength at these thicknesses, the steel must be quenched and tempered, and alloyed with molybdenum to produce consistent properties throughout the thickness of the steel. Together with carbon and nickel, molybdenum creates an exceptionally strong and tough steel. Furthermore, the addition of molybdenum helps the steel to maintain its excellent mechanical properties even after high temperature fabrication processes such as flame-cutting and welding.

There is a great difference between rack wear in rigs that are moved every few months and offshore wind installation vessels, which are moved daily. Also, some parts of the racks see more wear than others, depending on the depth of water where they are mostly used. Because the usage and wear of these jackups is so variable, they are inspected and overhauled every five years.

Shifting paradigms on the seas

Just a few years ago when global oil prices were relatively high, and exploration to find new reserves was cost-effective, the demand for jackup rigs, especially those designed for deeper waters, was very buoyant. The weaker oil market of recent years and improved recovery efficiency of existing wells have slowed offshore exploration, and consequently, the utilization rate of jackup rigs.

Nevertheless, jackups aren't ready to give up their sea legs yet, nor their role in offshore energy activities. Now, these vessels too are shifting paradigms to make wind power more cost-effective. ›

The ‘Pacific Orca’ vessel moves to a new location. © Swire Blue Ocean

Just ten years ago, wind turbines had to be assembled from vessels that bobbled unstably in the water or from oversized, expensive offshore cranes. Today, installation vessels with jackup legs provide a firm, self-moving platform for faster operation, improving the viability and profitbility of the offshore wind sector. In this vein, molybdenum-containing steel has played a small but indispensable role in advancing renewable power. Energy prices and trends may rise, fall, and shift like the roaring tides on which the jackups surf, but here the application of molybdenum remains as unwavering as the jackups’ legs themselves. (AH)

The shape of gear racks is produced by flame cutting heavy plates. © Dillinger