DOWNHOLE HEAVE COMPENSATOR

A TOOL DESIGNED BY HINDSIGHT

Kirk Shirley

You might say we started building downhole heave compensators in self-defense. We were trying to keep drillships and semi-submersibles from wiping out our underreamers.

You might say, too, that we were late getting into the act. We didn't begin marketing our downhole heave compensators until early 1973.

But we were pleased with the way it all worked out. Our late arrival on the scene made it possible for us to analyze the tools already in service, study their good points, take warning from their bad points. Influenced as we were by the merits and demerits of previously build hardware, you might way that A-Z International's downhole heave compensator was designed by hindsight.

There's a lot to be said for hindsight. In our case, it resulted in a tool yielding at least 500 trouble-free rotating hours. And it stopped the destruction of our underreamers.

What was happening to our underreamers before 1973 shouldn't happen to anybody's downhole tools. Run from drillships and semi-subs below the then-prevalent bumper subs, they lost their cones, broke their cutter arms, and earned black-eyes for underreaming in the marine environment. We completely redesigned our underreamer; but, still, report after report told of underreamer failure because unbalanced bumper subs locked under heavy torque loading and failed to reciprocate. The underreamer, then, was picked up off bottom and slammed back when the vessel heaved down.

To protect our own interests properly, we set out to develop a downhole heave compensator that would reciprocate freely at all times, regardless of torque loading.

For over two years we studied every conceivable design. We made experimental tests with all types of packing, lubricants, tool joint threads and materials to determine those types which would best satisfy the criteria established for this tool. Our objectives:

1. Good material
2. Good workmanship
3. Properly designed tool joints
4. A drive section which will reciprocate under full torque loading
5. Packing which will hold up and reciprocate under high temperature and high differential pressure
6. Lubricant which will maintain its molecular structure and low coefficient of friction at all temperatures for at least 1000 hours continuous service.

We sought minimum downtime and maintenance, a tool that would reciprocate under full torque loading for at least 500 hours on bottom without pulling the string except to change bits. At today's high rig costs for drillships and semis the savings would offset the cost of the tool in just a few runs.

What was needed, in short, was a fully-balanced downhole heave compensator. Unbalanced bumper subs, our studies convinced us, will not get the job done. These unlubricated tools are fine for fishing jobs on land where they are used intermittently to release grappling tools by jarring, or, in some cases, with minimal right or left hand torque, but they aren't designed for continuous reciprocation under high torque loading commensurate with off-shore drilling from a floating platform. Sand and mud circulate through the torque transmission section, acting like emery cloth on the driving and driven members, At best, the unlubricated bumper subs can last only a few hours, making the cost of downtime and maintenance prohibitive.

The heart of any downhole heave compensator is the torque transmission system. In the A-Z system, the drive inserts are rectangular, and in assembly, the driving and driven faces thereof are in radial contact with the mandrel and outer sleeve. In other words, if this line of contact were extended, it would pass through the center of the tool, or nearly so. On the other hand, the torque transmitted by the tool is tangential, and the force is applied at right angles to the faces of the driving and driven members described above. Thus, under torque loading, the drive inserts are not forced up into the outer sleeve; neither are they forced down into the mandrel. In a sense, they are free-floating and are not subjected to any wedging action due to torque loading.

The tool made available in 1973 was not the lowest cost design considered during the two-plus years of investigation into downhole heave compensation. In view of the logistics involved in today's worldwide off-shore drilling program, the established parameters for downhole tool selection have moved price to the bottom of the list. You can't afford not to have the best, even if it costs twice as much. First comes performance. How long it will stay on bottom? Second comes maintenance. Third, spare parts, etc. But at $30,000 and $40,000 a day, price has got to be last!

What is the subject matter of this article?

What does a downhole heave compensator seem to do? (What evidence to you have for your response?)

What does the author mean about the role of hindsight in design?

What difference would it make if these processes were not going on in a marine environment?