“Lifejackets” for deep-sea drills

Tapping into new crude oil and natural gas sources is growing increasingly complicated. Although many reservoirs are well-known, they can’t be exploited with today’s extraction technology. In order to enable oil and gas to be obtained from the deep sea, for instance, Empa is going to team up with industrial partners to develop floating units that are supposed to prevent drill pipes several kilometers in length from breaking.

TEXT: Dominique Bitschnau / PICTURES: Shell, Trelleborg, Empa / ILLUSTRATION: Empa

At present, around 60 percent of the global energy needs is fulfilled by crude oil and natural gas. And the worldwide demand for energy keeps on rising. Obtaining crude oil with conventional extraction techniques, however, has hit a brick wall. Using controversial methods such as “fracking”, the oil industry is now trying to use the available reservoirs more effectively. After all, there are still enormous oil reserves; the problem is that the technical means to extract it have been lacking thus far.

Deep-sea oil and gas deposits are attractive, for instance – in other words, around 40 percent of the reservoirs that had been newly discovered between 2005 and 2009. Until now, however, drilling has only been possible to depths of 3,000 meters. Due to the heavy deadweight and stresses while drilling, the steel drill pipes are in dan-ger of breaking apart at greater depths. In order to prevent this, floating units are attached to the drill pipe and the load is considerably taken off the deep-sea drill by the increased buoyancy. The buoyancy module used thus far, a so-called “drill riser”, is about as big as a human being and consists of synthetic foam with spherical air pores. “However, this foam has one major drawback: the micro-bubbles implode at great depths because the pressure is too high,” explains Empa researcher Jakob Kübler. Using pressure-resistant floating units, he and his team are looking to make it possible to drill at depths of up to 6,000 meters.

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Moderately priced buoyancy modules

The goal for Empa and its partners is to replace the current synthetic foams with more resistant ceramic balls. Such balls already exist and are used as buoyancy aids for submarines, for instance. Thanks to its good stability and pressure resistance, a ten-centimeter ball can withstand over 200 tons, the weight of five heavy trucks. The problem is the price: one ball costs around US$ 800 and thousands of them are needed for one deep-sea drilling operation. At these costs, the method is not worthwhile for oil companies. Therefore the british product development contractor Pera Technology and the drilling supplier Molded Forms asked Empa for scientific support. And Jakob Kübler found the task quite interesting: “Developing an optimized ball with as little deadweight as possible and low production costs is a major challenge,” he says.

In order to generate a lot of buoyancy, the ball should be as light and bulky as possible, which is why Kübler is looking to produce balls with a thin wall and as little ceramics as possible. The balls should be made of normal, low-priced ceramic powder, which Kübler mixes with water and chemical additives to form a so-called slurry – a mixture with a consistency much like a thin milkshake.

Wanted: the perfect ball

The trick now is to produce a precision ball from this mass that also retains its shape when fired in the oven. After all, only perfectly round balls can bear up against the tremendous pressure in the deep sea. Consequently, simply piecing together two halves to produce the balls is not an option as the ceramic balls need to be produced seamlessly in one go. “We simply can’t afford for the buoyancy units to fail while in use,” says Kübler. Repair work at such depths would mean enormous costs, breakdowns and environmental pollution. In order to make the balls even more robust, it is planed to cover each of them in an elastomer material, which would enable the impact-sensitive ceramic balls to be transported and installed safely.

The prototypes, so it is planned, could be ultimately tested by a Swedish specialist company, which already manufactures buoyancy units for deep-sea drilling. After the completion of the project, there should be a few hundred balls left over as evidence that they work immaculately and are cheap to produce. //

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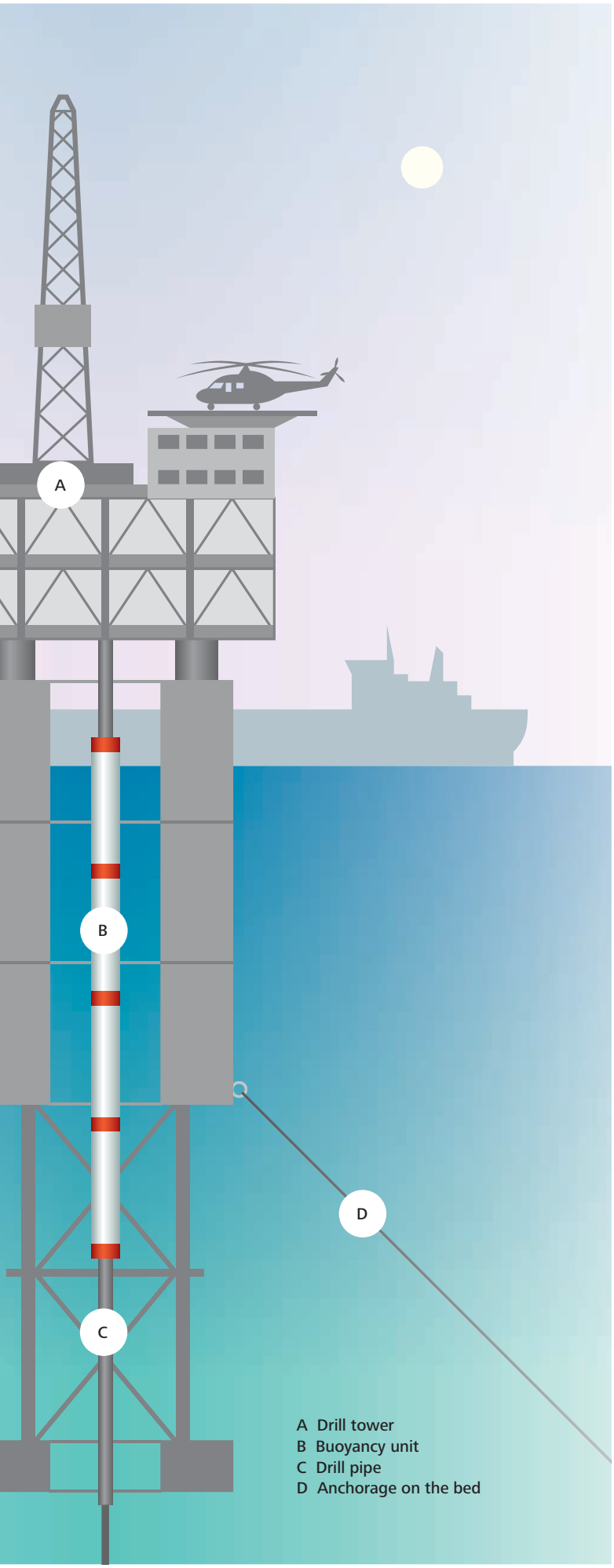

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Buoyancy modules piled up before use. The white modules with the orange end caps, so-called “drill risers”, are roughly the same size as a person and attached to the drill pipe. Inside, synthetic foam produces the buoyant effect. In order to make it possible to extract oil and gas from great water depths, Empa and its partners want to replace the synthetic foam with special pressure-resistant ceramic balls.

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Diagram of an oil rig with fitted buoyancy units. Under its own heavy weight, the steel drill pipe risks breaking apart at great depths. In order to reduce the tensile load on the pipe, buoyancy units are attached to it.

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Ceramics expert Jakob Kübler in his lab in Dübendorf: He produces special ceramics with suitable geometry and defined properties from a semi-liquid substance “with the consistency of a milkshake”.

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