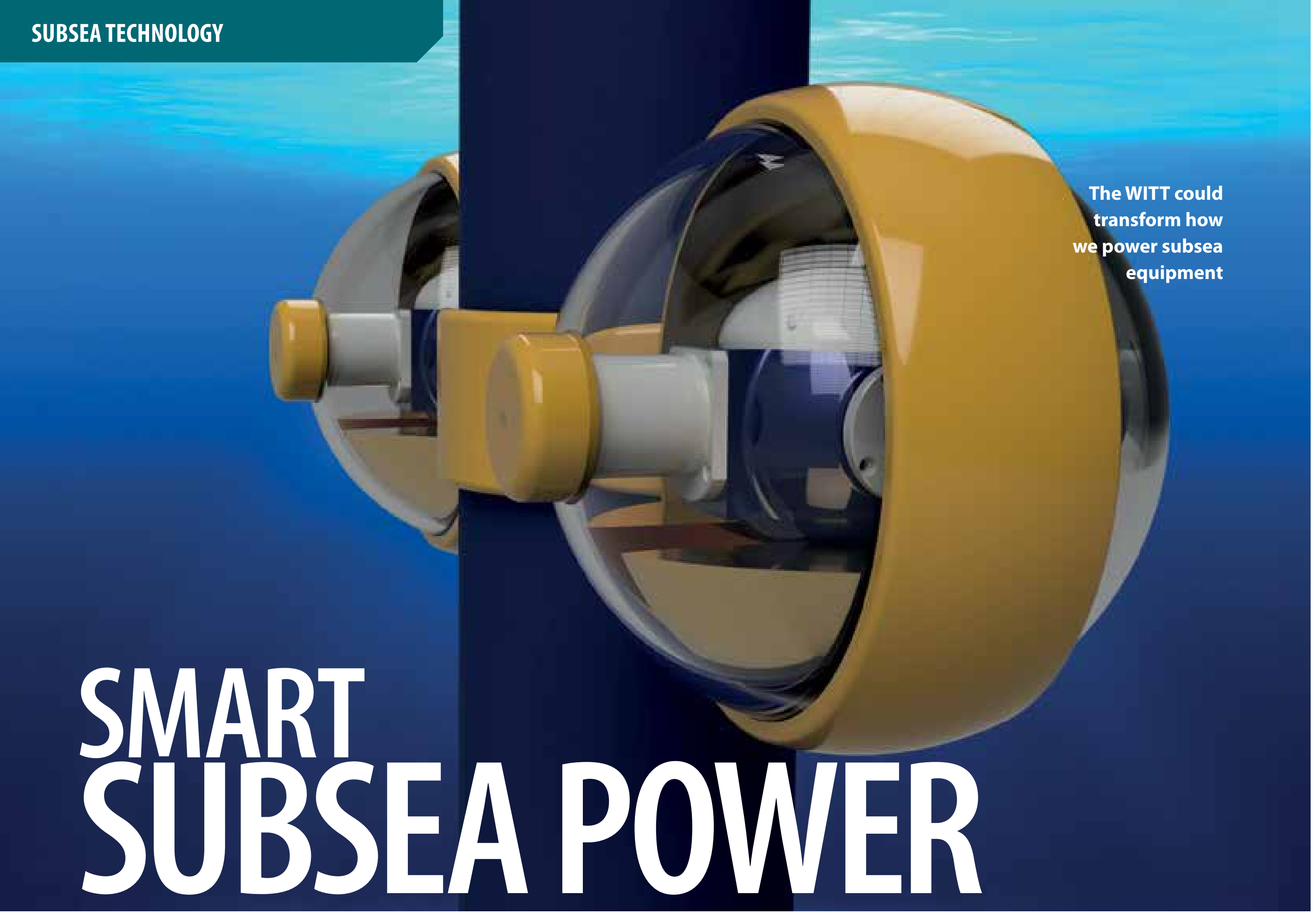


The WITT could transform how we power subsea equipment

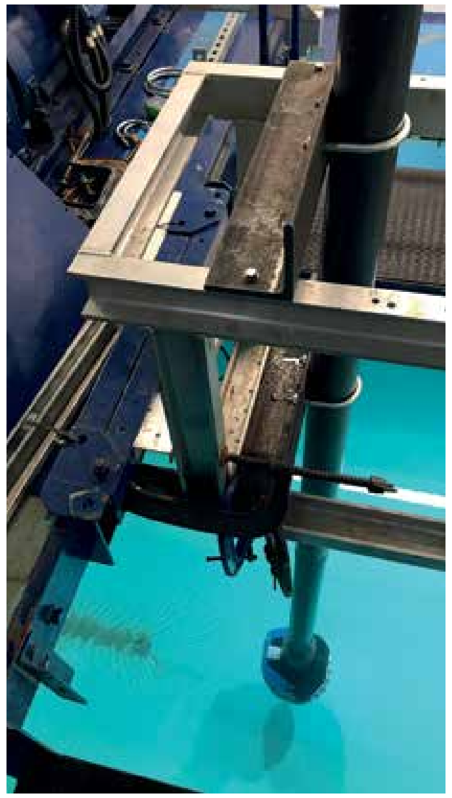
SMART SUBSEA POWER

Martin Wickett explains how his firm's novel energy harvesting solution could have a huge impact on subsea operations

The WITT (Whatever Input to Torsion Transfer) energy device converts chaotic motion in six degrees of freedom to a single unidirectional output, which can be coupled to a generator to provide electrical power. The WITT system is described as follows:

"Contained within a sealed unit, a WITT uses two pendulums connected to a flywheel to generate electricity. Movement causes the pendulums to swing, they are attached to a shaft that then turns a flywheel in one direction. The flywheel is connected to a generator, which produces electricity. The unit harvests chaotic motion, fast, slow or erratic, turning it into useable power. The company claims that no other device captures energy from all six degrees of motion. Where most energy harvesting devices are point absorbers, taking up-and-down or side-to-side motion and turning it into useable power, the WITT takes all motion." *(WITT, 2018)*

Although the WITT device has multiple uses both on land and sea, and also in harvesting human animal motion, this subsea application is focused on small-scale power generation for subsea electronics, particularly where the replacement of battery packs is an expensive offshore activity requiring remotely operated vehicles (ROVs) and their supporting ships and crew.



Real-world tank testing recently took place at Solent University

The WITT system of this size is approximately 250mm in diameter and is capable of generating 5W. It requires movement to generate power. The ideal operating point is an amplitude of up to 100mm with a frequency of 2Hz. Larger systems will require lower frequency, but amplitude would be larger. The power output and target frequency is tunable within the device by changing the internal pendulum mass distribution. To achieve these target operating conditions for the WITT generator, vortex induced vibration (VIV) was chosen to drive the system. The design philosophy was to develop something simple and scalable, that could be deployed cost effectively. A patent has been filed and is now pending. WITT conducted trials at Solent University flow tank over a three-day period.

VIV OPERATING CONCEPT

The operating concept of the subsea WITT is motion from VIV. This is achieved by connecting the WITT energy device to cylindrical cross section pipe sections, the periodic vortex shedding generates lift and drives the WITT generator. The aim is to create a modular system that can be varied for sites with different conditions or power requirements with ease of installation and minimum maintenance at the forefront.

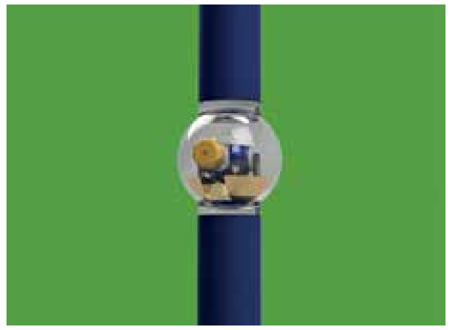
High density polyethylene (HDPE) has been initially selected for the cylindrical pipe sections due to its low cost, fatigue performance and corrosion resistance. HDPE is readily available and can be easily joined using electro-fusion techniques offshore too. For different sites/sizes other materials could be used, such as composites or steel with the necessary level of scrutiny applied to fatigue life and corrosion protection. The circular cross section pipe is also useful as a conduit for power/communication cables, enabling an entirely self-contained system.

A wide range of design options were studied to determine the parametric basis of the system as multiple parameters can be adjusted to affect the performance. Also, the natural frequencies and mode shapes of the system require consideration to ensure the WITT energy converters are placed at the antinodes where displacement is at a maximum.

POSSIBLE APPLICATIONS

The WITT device has many applications harvesting natural occurring motion energy (NOME) that is all around us. This subsea version driven by VIV has two primary applications as follows, although there may be many more:

Subsea power: Where the primary aim is to power subsea electronics in remote locations where battery replacement is a costly exercise. The low maintenance strategy and lack of external moving parts lend it to uninterrupted operation. Low ocean current speeds can be exploited by increasing the length of the system. Alternatively, areas with high current speeds can also be used by reducing the length of the system. Tuning is then achieved for a given power requirement by adjusting the pipe diameter and stiffness. Also, a top float can be used to adjust the line tension. The application could be used to power ROVs or autonomous underwater vehicles (AUV) charging stations, or wherever a remote subsea power requirement exists, such as remote sensing in aquaculture and scientific data. The WITT energy converter would charge local energy storage for demand when required. Some of this energy may also be used for impressed current corrosion protection systems.



A WITT of this size can be used to power subsea electronics

The WITT can be put to use for a number of subsea applications

Riser/umbilical VIV reduction measures: Here the WITT generator load can be varied to maximise the opposing force, effectively damping the VIV magnitude. This could be a pre-set load, or an active tuning performed remotely or onboard using an array of WITT devices along the length of the riser.

TANK TESTING

The purpose of the testing was to cover several aspects; observe VIV occurrence, determine the effect of the WITT energy device on the overall system dynamics, measure WITT displacements and frequencies over a range of operating conditions.

A full scale 5W WITT drivetrain was available so a full-scale test programme, looking at the first section of the system comprising clamp, pipe and WITT in an inverted configuration, was carried out.

A three-axis accelerometer and gyro was fitted to the WITT to determine the displacement amplitude and VIV frequencies.

The extent of VIV present in the physical tests is very encouraging, the feedback of the WITT drivetrain and relatively short pipe section still results in an easily driven system. The VIV prediction techniques would benefit from further investigation to improve their fidelity.

CONCLUSIONS

The simulations, validated by tank testing, prove that the subsea WITT energy harvester using VIV is a feasible technology. The solution has the following advantages: current direction independent; modular; scalable; tuneable; sealed generator; no external moving parts; and no shock loads

The scalability and modularity of the subsea WITT allows for cost-effective tailoring for a site's individual metocean characteristics and power requirements. A wide range of applications is possible, from powering subsea monitoring equipment through to reduction of riser fatigue by reducing VIV. ●

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