ROV Power Cable Ampacity in Areas With High Ambient Temperatures

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INTRODUCTION: Overheating of ROV Umbilicals during warmwater ROV operations is a concern. The modelling covered Main lift Umbilicals and Tethers at 32 Deg C Seawater. System voltage was 3000V, 60 cycles and a phase current of 30A.

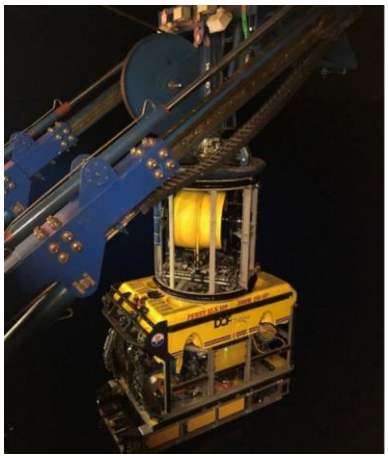

Figure 1. ROV and Tether Management System (TMS)

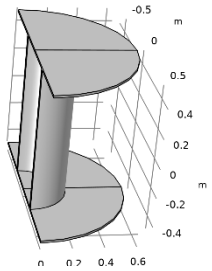

Figure 3. TMS Winch Model

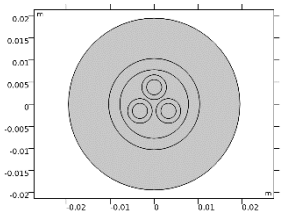

Figure 4. Tether Model

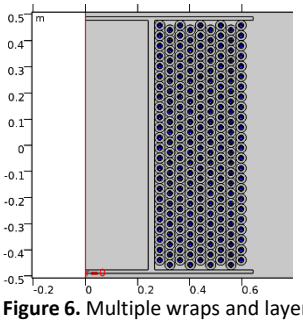

Figure 6. Multiple wraps and layers of Tether on the winch.

COMPUTATIONAL METHODS: The full drum of Tether cable was modelled considering the Subsea case and on deck cooling down after operations.
The first magnetic field study was carried out in the frequency domain followed by a heat transfer study in the time domain.

$$\nabla \times \mathbf{H} = \mathbf{J}$$
$$\mathbf{E} = -j\omega\mathbf{A}$$
$$\mathbf{B} = \nabla \times \mathbf{A}$$
$$\mathbf{E} = -j\omega\mathbf{A}$$
$$\mathbf{J} = \sigma\mathbf{E} + j\omega\mathbf{D}$$
$$\mathbf{n} \times \mathbf{A} = 0$$

Figure 6. Magnetic field governing equations.

$$\mathbf{q} = -k\nabla T$$
$$Q = Q_0$$
$$-\mathbf{n} \cdot \mathbf{q} = 0$$
$$-\cdot\left(-D_{P1}\nabla G\right) = -q_{r,net}$$
$$= \frac{\varepsilon}{2(2-\varepsilon)}\left(4\pi I_{b,w} - G\right)$$
$$\rho C_p \mathbf{u} \cdot \nabla T + \nabla \cdot \mathbf{q} = Q + Q_{ted}$$

Figure 7. Heat Transfer governing Equations.

The Tether was electrically loaded for sufficient time to observe when the temperature reached 85 Deg C with a boundary of 32 DegC sea water. Cooling on deck in air was them simulated.

RESULTS: The cable reach 85 Deg C in 8 hours with highest temperature on the winch mid line.

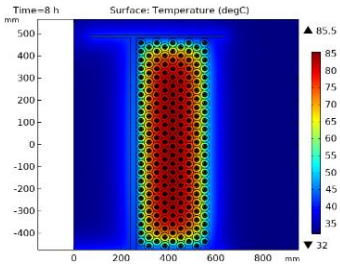

Figure 7. Heat distribution

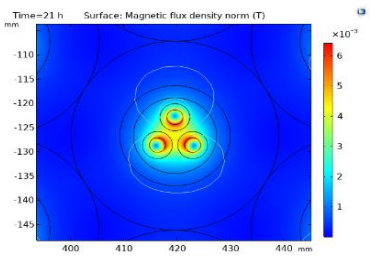

Figure 8. Eddy currents between Phases.

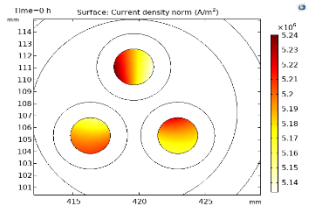

Figure 9. Current distribution across conductor cross section

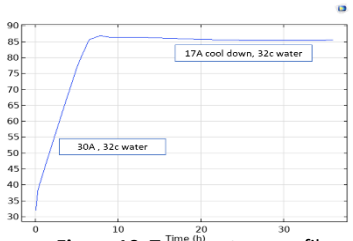

Figure 10. Temperature profile at winch mid-line

Validation: Full scale validation test was carried out with a TMS in air and a 30A load bank using optical temperature sensing in the core of the Tether.

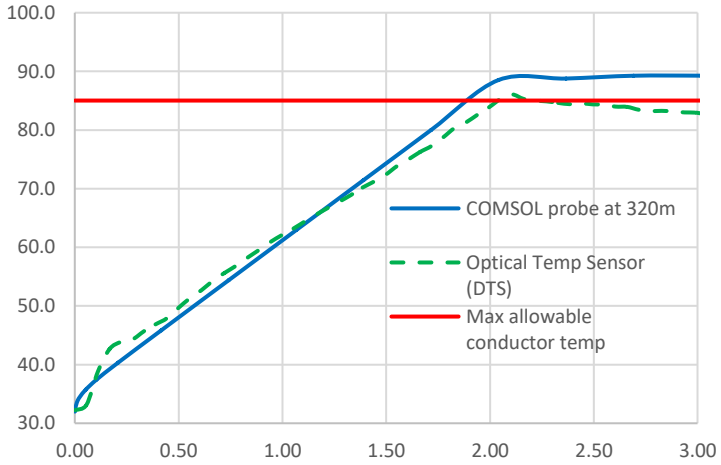

Figure 11. Temperature (DegC) over Time (Hrs) comparing the multiphysics model to a real-time optical temperature sensor (DTS)

CONCLUSIONS: Subsea operations in warm water require ampacity limits to be calculated, especially related to the subsequent dives after a period of high power Subsea operations perhaps with a short cool down time. The use of an optical fiber and distributed temperature sensing (DTS) system to validate the model has improved our confidence in the modelling results, we recommend the use of a DTS to monitor core cable temperature real-time, combined with a Multiphysics simulation.

REFERENCES:

1. COMSOL, AC/DC Module users guide (2018)
2. N.Vedachalam ea. Ampacity Derating Analysis of Winch-Wound Power Cables, IEEE Journal of Oceanic Engineering Volume 41, No 2 462-467, (2016)