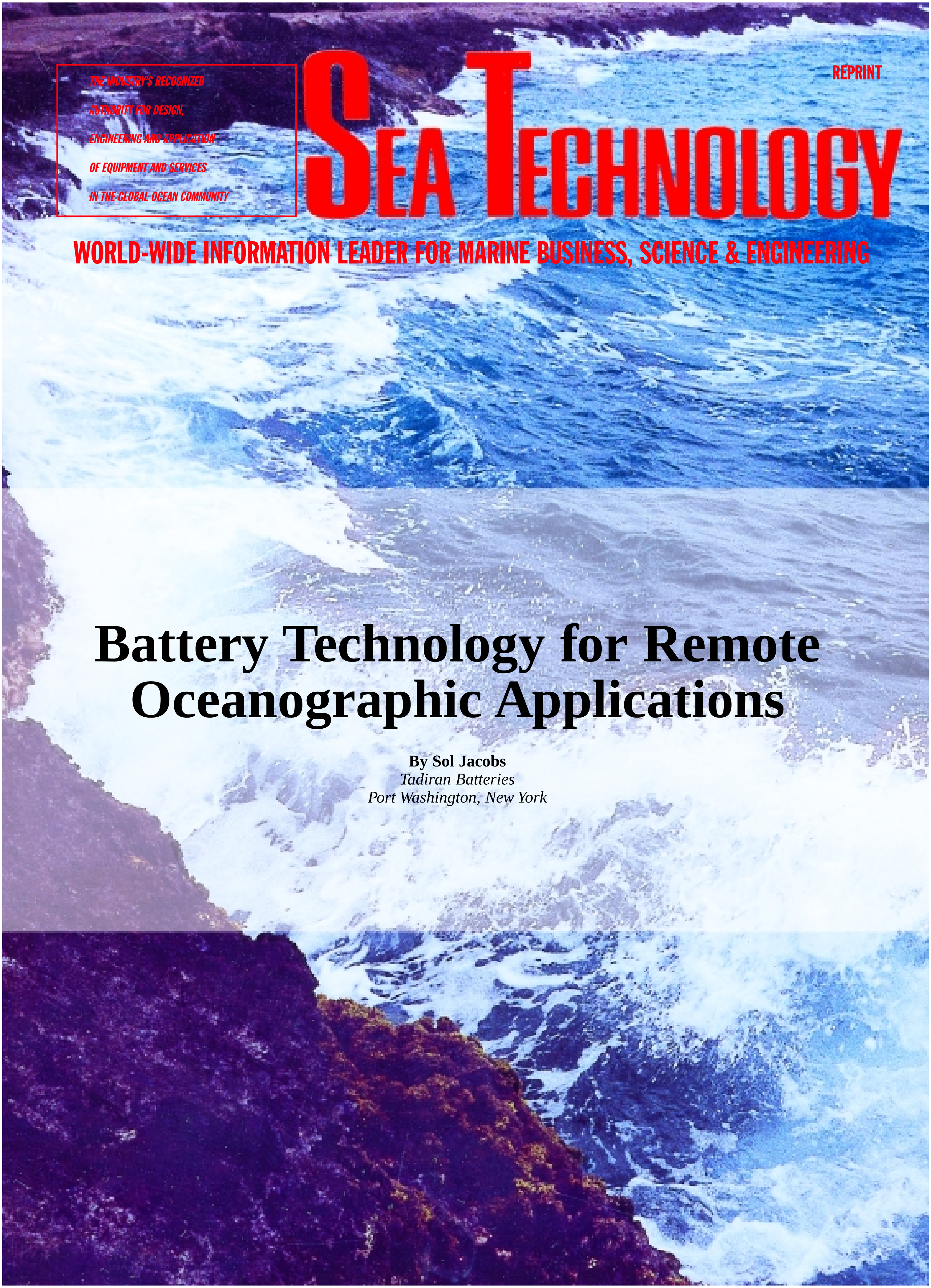

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Battery Technology for Remote Oceanographic Applications

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Bobbin-Type Li/SOCL2 Cells with Hybrid Layer Capacitor for Powerful Performance, Longer Life, Reduced Size & Weight & Improved Safety

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Rapid advancements in remote oceanographic technology are creating many new product design opportunities throughout the marine industry. But while marine technology is moving full speed ahead, battery manufacturers have been struggling to keep pace with the needs of product design engineers who are looking to pack more product features into less space, with less weight, or extend product life.

Oceanographic Applications

The explosive growth of marine products is giving rise to a variety of high current-pulse applications that require low background currents and brief periods of high-current pulses over an extended period of time. These applications include buoys of all types (drifting, moored, ARGO, etc.), may-day and other emergency systems, GPS and ARGOS tracking devices, current meters, transponders, harbor lights, acoustic releases, seismometers and other oceanographic devices.

At present, the two battery technologies of choice tend to be alkaline battery packs and packs made with spirally wound lithium cells. Alkaline packs tend to be large and heavy, and can be affected by wide temperature ranges.

Lithium batteries are often preferred for high current-pulse marine applications due to their inherent long life and high energy density. These applications typically require a battery power system that can withstand extreme temperatures and harsh marine environments. Long life and reliability are also important concerns, as battery failure will result in total system failure for stand-alone systems in remote locations with no back-up power source. Safety is always a major concern, as is cost. Reduced size and weight are important requirements for transportation.

With oceanographic devices becoming complex and feature-rich, the performance capabilities of current lithium-battery technology is being stretched to the limits. Spirally wound lithium cells, while adequate in supplying high current pulses over a wide

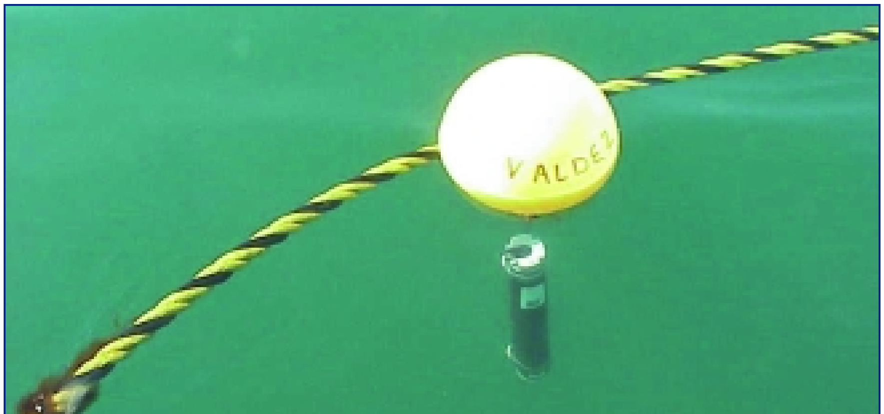
Oceantronic's GPS/ice buoy being retrieved by helicopter to the Arctic for use in experiments measuring wind, temperature sunlight and ice thickness near the North Pole. (Courtesy Sigrid Salo NOAA/PMEL.)

NotekUSA's Aquadopp GPS current meter being installed by Canadian Wildlife Service as part of a field study in Hudson Bay. The Aquadopp is used to study the effects of tidal currents on eider ducks in areas near the open ocean in seas otherwise covered with ice. (Courtesy of Grant Gilchrist, Canadian Wildlife Service.)

temperature range, lack the energy density of bobbin lithium cells, and are considered by many not to be as safe in use or in transport as the bobbin cells. Standard bobbin-type lithium thionyl-chloride (Li/SOCL2) cells deliver extremely high energy density, high cell voltage, good low-temperature characteristics, low self-discharge rate and good safety characteristics. However, standard bobbin-type cells have two drawbacks: passivation after storage at elevated temperature, and low current due to low-rate design. As a result, these cells do not have the power capability required for high current-pulse applications.

Same operating life with smaller size for use in GPS/ice buoys. Oceantronics' original battery pack (left) used 380 alkaline D cells (54 kg). The new battery pack (right) uses 32 lithium thionyl chloride D cells and four hybrid layered capacitors (3.2 kg).

To address this problem, engineers at Tadiran have developed a hybrid lithium technology that combines bobbin-type lithium thionyl-chloride chemistry with a hybrid layer capacitor (HLC). The resulting cell delivers higher energy density and high current pulses without any passivation or voltage-delay problems. This was not the first time that lithium batteries and capacitors have been combined, but the need for high current pulses did involve special modifications to the capacitor, as these hybrid layer capacitors are specifically designed for use with lithium batteries.



NortekUSA's Aquadopp GPS current meter at the Valdez, Alaska fish hatchery. (Courtesy James Dryden and David Orders)

Buoy Pack-90 Percent Smaller

Earlier this year, Oceantronics Inc. (Honolulu, Hawaii), a manufacturer of scientific data collection devices, introduced this new hybrid lithium-battery technology to its GPS/ice buoys. To create a smaller, more cost efficient buoy, Oceantronics chose the PulsesPlusTM hybrid lithium thionyl-chloride battery from Tadiran, the only battery currently available that combines a bobbin-type Li/SOCL2 lithium thionyl-chloride battery with a hybrid layer capacitor.

A leading supplier of commercial radars, GPS systems and peripheral equipment for the U.S. Navy and other federal agencies, Oceantronics developed GPS/ice buoys for NOAA/PMEL back in 1994. The original battery pack weighed 54 kilograms (kg), and required 380 alkaline D cells to operate for a period of one year. Early in 2001, Oceantronics delivered its latest generation of GPS/ice buoys to the North Pole Environmental Observatory for use in scientific experiments measuring the effects of global climate change on ice floating on the Arctic Ocean. The battery packs of these buoys weighed just 3.2 kg, and utilizing 32 D-cell lithium thionyl-chloride batteries and four hybrid layer capacitors.

Switching to this new hybrid lithium battery technology resulted in a significant size and weight reduction-over 90 percent. Ease of transport is extremely important to technicians working in frigid Arctic waters. Likewise, a number of the smaller lithium packs can be used in place of the larger alkaline packs, extending the operational life of the system many fold.

In developing its new generation GPS/ice buoy, Oceantronics required a battery that could withstand tests of -40°C prior to deployment. They also demanded that the batteries pass all UN standards for shipping non-hazardous goods.

Boosts Capacity, Extends Life

Whereas in the Oceantronics example hybrid lithium batteries were utilized to reduce space and weight, NortekUSA (San Diego), a manufacturer of current meters, utilized hybrid lithium technology to provide longer life within the same physical size as the present battery.

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Nortek's Aquadopp acoustic current meter and profiler substituted hybrid lithium battery packs for standard alkaline battery packs of equal size. In tests conducted by Nortek, the hybrid lithium solution resulted in greatly increased battery capacity. According to Lee Gordon of NortekUSA, "the LP175 (hybrid) lithium battery pack is well suited for use with Nortek's instruments, and should provide at least 3.3 times the capacity of our standard alkaline battery packs."

Other Oceanographic Applications

The two previous examples demonstrate the potential space-saving and life-extending benefits of hybrid lithium batteries versus alkaline battery packs. This hybrid technology also offers performance advantages over other lithium chemistries.

One recent example involves GPS seismic equipment designed to detect underwater movements of the Earth's crust for the purpose of studying plate tectonics, as well as to provide an early warning of seismic activity. These systems currently use 15 DD-size spirally wound lithium cells for an operational life of about one year.

Converting to Pulses Plus hybrid lithium batteries will permit a substantial increase in operational life, as 15 DD-size thionyl-chloride bobbin cells plus 15 AA-sized hybrid layer capacitors, can provide two years of service life. Increasing the operational life of the system to four years would entail the use of 60 spirally wound DD cells versus a hybrid solution of 30 bobbin DD cells and 15 AA-sized hybrid layer capacitors. The hybrid battery pack would be smaller, lighter, cheaper and much safer than the equivalent spirally wound lithium pack.

Cargo-Container Tracking

Another recent application involved a sea cargo-container tracking device that spends 30 days at a time at sea untethered (not connected to any power supply). The battery must provide 10 years of service life.

The present battery power solution requires two large DD spirally wound cells. Identical performance was achieved with two D-size PulsesPlus bobbin cells (about half the size of DD cells), plus four hybrid layer capacitors the size of AA cells.

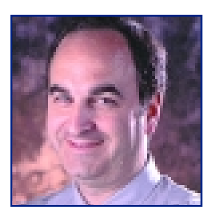
Conversion from spirally wound to PulsesPlus hybrid batteries resulted in a 25 percent size and weight reduction, as well as a 50 percent cost savings. The hybrid lithium solution is also safer for the container and the vessel.

Other applications have benefited from this new hybrid technology. For instance, light beacons that ran on lead-acid batteries or solar panels are now being retrofitted for hybrid lithium cells.

Conclusion

Of all the lithium chemistries utilized in various marine applications, bobbin-type Li/SOCL2 cells combined with a Hybrid Layer Capacitor shows unique promise for high energy-density/high current-pulse applications. Benefits include powerful performance, longer life due to lower self-discharge, reduced size and weight, and improved safety.

As oceanographic applications grow increasingly complex, this and other lithium battery technologies will be continually refined to meet the demands of design engineers looking to pack more power and performance into less and less space. */st/*



For the past seven years, Sol Jacobs has served as the vice president and general manager of Tadiran Batteries. Jacobs holds a master's degree in business administration, as well as an engineering degree, and has spent more than 20 years in the high tech industry, including work with remote power applications involving batteries, photovoltaics and turbo generators.