DF24-02 · draft prepared 2026-06-19 · dronefactory24.uk

Seawater-Activated Galvanic Auxiliary Cell with Sacrificial Magnesium Anode for Trickle-Charging an Avionics and Sensor Bus of a Submersible Drone Without Powering Flight

Marginal · 62.2/100 | 12 claims

TECHNICAL FIELD

Auxiliary electrical power generation for submersible unmanned vehicles using a seawater-activated galvanic cell to extend avionics and sensor endurance.

ABSTRACT

An auxiliary power subsystem for a transmedium drone comprises an aluminium structural electrode and a consumable sacrificial magnesium electrode separated by a flow-through channel that admits seawater only when the vehicle is submerged. On submersion an immersion-actuated port opens the channel, the seawater acts as electrolyte, and the galvanic couple generates low-power direct current. A conditioning circuit regulates the output and directs it to trickle-charge an avionics and sensor bus and, within a bounded rate, to slowly top up a primary lithium-polymer battery during submerged loiter. The magnesium electrode is consumed during operation, so the cell is a primary auxiliary source bounded to low-power housekeeping loads; it is expressly not a flight power source and cannot sustain rotor or thruster propulsion. The subsystem extends submerged loiter and standby endurance, keeps navigation and sensing alive during quiescent periods, and reduces primary-battery depletion while the vehicle waits, drifts, or performs low-rate sensing. Claims are scoped to auxiliary, avionics, sensor, and loiter-extension functions.

BACKGROUND

Small submersible drones are battery limited. Lithium-polymer packs that are sized for short aerial flight are quickly depleted when a vehicle must also loiter submerged while sensing or waiting for a tasking, and battery exhaustion during submersion risks loss of the vehicle. Seawater-activated batteries are well known in marine engineering: magnesium and aluminium anodes coupled in seawater electrolyte produce useful current and have been used in marine beacons, sonobuoys, and emergency lights. Sacrificial magnesium and aluminium anodes are also standard for cathodic corrosion protection of hulls. However, these prior uses are stand-alone power cells or corrosion anodes; they are not integrated into a transmedium drone as a submersion-gated auxiliary that uses a structural aluminium member as one electrode and conditions its output specifically to sustain an avionics and sensor bus and to bounded-rate top-up of a primary battery. A naive integration risks two failure modes: over-claiming the cell as a flight power source, which the chemistry cannot support at rotor power levels, and continuous corrosion of the structural electrode even when dry. There remains a need for a submersion-gated galvanic auxiliary that opens only when wet, that is bounded to low-power housekeeping and loiter-extension loads, and that protects the structural electrode when the vehicle is in air.

SUMMARY OF THE INVENTION

The invention provides a submersion-gated galvanic auxiliary cell for a transmedium drone. An aluminium structural electrode and a consumable magnesium electrode are arranged across a flow-through channel. An immersion-actuated port keeps the channel closed in air and opens it on submersion so seawater becomes the electrolyte and the couple generates low-power DC. A power-conditioning circuit regulates the output and, under a controller, distributes it to trickle-charge an avionics and sensor bus and, at a bounded charge rate, to top up a primary lithium-polymer battery during loiter. The controller enforces a hard cap so the auxiliary output never supplies propulsion-level current; the cell is a primary anode-consuming auxiliary, not a flight source. A flush or purge feature clears the channel on water exit to limit residual corrosion, and the consumable magnesium electrode is replaceable. The result is extended submerged loiter and standby endurance and reduced primary-battery depletion during quiescent submerged operation, without any claim of sustaining flight.

DETAILED DESCRIPTION

FIG. 1 is a schematic of the auxiliary power subsystem showing an aluminium structural electrode (30), a consumable magnesium electrode (32), a flow-through channel (34), an immersion-actuated port (36), a power-conditioning circuit (38), an avionics and sensor bus (40), and a primary lithium-polymer battery (42). FIG. 2 is a section view showing the channel (34) between the electrodes with the port (36) closed in air. FIG. 3 is the same section with the port (36) open during submersion and seawater (44) flowing as electrolyte. FIG. 4 is a block diagram of the power-conditioning and distribution circuit with a controller (46) enforcing a current cap. FIG. 5 is a flowchart of the auxiliary power management method. FIG. 6 is a detail of the replaceable magnesium electrode cartridge and a purge feature (48). In air, the immersion-actuated port (36) is closed, so no electrolyte bridges the electrodes (30, 32) and negligible galvanic current flows, protecting the structural electrode from unnecessary consumption. On submersion, an immersion or pressure trigger opens the port (36); seawater (44) enters the channel (34) and forms the electrolyte of a galvanic couple in which the magnesium electrode (32) is the anode and is progressively consumed, while the aluminium structural electrode (30) serves as the cathode and as part of the airframe. The couple develops a low open-circuit voltage and modest current. The power-conditioning circuit (38) regulates this output. Under the controller (46) the conditioned current is directed first to the avionics and sensor bus (40) to sustain navigation, sensing, and communication during submerged loiter, and any surplus is applied to the primary battery (42) at a bounded trickle rate. The controller (46) enforces a hard current cap so that the auxiliary output is restricted to housekeeping and loiter-extension loads and never supplies propulsion-level current; propulsion remains powered solely by the primary battery (42). On water exit the port (36) closes and the purge feature (48) clears residual seawater from the channel (34) to limit further corrosion. The magnesium electrode (32) is provided as a replaceable cartridge (FIG. 6) so the consumed anode can be renewed between missions. In an embodiment a coulomb counter logs anode consumption to estimate remaining auxiliary capacity.

DRAWINGS

FIG. 1 is a schematic of the auxiliary power subsystem with the aluminium structural electrode, consumable magnesium electrode, flow-through channel, immersion-actuated port, conditioning circuit, avionics bus, and primary battery; FIG. 2 is a section with the port closed in air; FIG. 3 is a section with the port open and seawater flowing as electrolyte during submersion; FIG. 4 is a block diagram of the conditioning and distribution circuit with a current-cap controller; FIG. 5 is a flowchart of the auxiliary power management method; FIG. 6 is a detail of the replaceable magnesium cartridge and purge feature.

CLAIMS

1. A method of extending auxiliary electrical endurance of an unmanned vehicle configured to be submerged in seawater, the method comprising: on submersion of the vehicle, admitting seawater through an immersion-actuated port into a flow-through channel between an aluminium electrode and a consumable magnesium electrode so that the seawater acts as an electrolyte of a galvanic cell; generating a low-power direct current from the galvanic cell; conditioning the direct current; and supplying the conditioned direct current to an avionics and sensor bus of the vehicle and, subject to a current cap, trickle-charging a primary battery of the vehicle, wherein the conditioned direct current is restricted by the current cap below a current required for propulsion of the vehicle.

2. An auxiliary power system for a submersible unmanned vehicle, the system comprising: an aluminium electrode forming part of a structure of the vehicle; a consumable magnesium electrode; a flow-through channel between the electrodes; an immersion-actuated port arranged to close the channel in air and to open the channel on submersion to admit seawater as an electrolyte; a power-conditioning circuit coupled to the electrodes; and a controller configured to direct conditioned output of the power-conditioning circuit to an avionics and sensor bus and, subject to a current cap below a propulsion current, to a primary battery, the consumable magnesium electrode being an anode that is consumed in use.

3. The method of claim 1, wherein the aluminium electrode is a structural member of an airframe of the vehicle and the magnesium electrode is provided as a replaceable cartridge.

4. The method of claim 1, wherein the immersion-actuated port is triggered by at least one of an immersion sensor and a pressure sensor indicating submersion.

5. The method of claim 1, further comprising, on exit of the vehicle from water, closing the port and purging residual seawater from the flow-through channel to limit corrosion of the aluminium electrode.

6. The method of claim 1, further comprising counting charge drawn from the galvanic cell to estimate a remaining capacity of the consumable magnesium electrode.

7. The method of claim 1, wherein supplying the conditioned direct current comprises prioritising the avionics and sensor bus and directing only a surplus, within the current cap, to the primary battery during a submerged loiter.

8. The method of claim 1, wherein the current cap is set such that the galvanic cell sustains housekeeping and loiter-extension loads and does not sustain rotor or thruster propulsion.

9. The system of claim 2, wherein the controller is configured to prioritise the avionics and sensor bus over the primary battery and to enforce the current cap such that the conditioned output never supplies a propulsion-level current.

10. The system of claim 2, further comprising a purge feature arranged to clear residual seawater from the channel on water exit, and wherein the consumable magnesium electrode is a replaceable cartridge.

11. The system of claim 2, further comprising a coulomb counter arranged to log consumption of the magnesium electrode and to report a remaining auxiliary capacity to the controller.

12. The system of claim 2, wherein the immersion-actuated port is biased closed in air to limit galvanic consumption of the aluminium electrode while the vehicle is not submerged.

PATENTABILITY SELF-ASSESSMENT (30-FACTOR)

Patentability	76.0%
Prior-art position	52.0%
Technical merit	56.0%
Commercial	56.0%
Composite genius score	**62.2/100 (Marginal)**

FILING ROUTES

United Kingdom (UK IPO)
GB national application at UK IPO with combined search and examination; modest scope advised so claims stay bounded to auxiliary and avionics use to survive seawater-battery prior art.

Ireland (IPOI / Irish PATO)
IE 10-year short-term patent is a realistic fit given the incremental nature, with optional EPO or PCT extension if the bounded-auxiliary framing examines well.

PRIOR-ART VERIFICATION (LIVE SEARCHES)

UK IPO patent search (Ipsum)
UK national register and file inspection
https://www.search-for-intellectual-property.service.gov.uk/SearchByNumber

Espacenet (EPO)
European/worldwide prior-art search
https://worldwide.espacenet.com/patent/searcl
q=seawater%20galvanic%20aux%20range%2

Google Patents
Full-text + family view
https://patents.google.com/?q=
(seawater%20galvanic%20aux%20range%20extender%20drone%20UAV%20transmedium)&type=PATENT

IPOI (Irish Patents Office)
Irish national filing route (short-term + full-term
https://www.ipoi.gov.ie/en/types-of-ip/patents/

EPO CPC B64U (UAS)
Unmanned-aircraft classification
https://worldwide.espacenet.com/patent/search?q=cpc%3DB64U