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Study on Power Supply and Mounting Issues for Point-Type Current Meters in Marine Applications

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ABSTRACT

This paper investigates the challenges of power supply and equipment mounting when using point-type current meters for velocity measurement in marine environments. The Vectrino Doppler point-type current meter manufactured by Norway's Nortek was employed for measurements, offering advantages such as high sampling frequency, excellent accuracy, and compact size. To meet the demand for long-term continuous power supply at sea, an MT1000S uninterruptible power supply (UPS) combined with four 100AH batteries was selected, enabling over 24 hours of uninterrupted system operation. For the mounting bracket, a removable galvanized steel structure was designed. Stability was enhanced through rectangular interlocking and wire fastening, supplemented by galvanized steel pipes to minimize measurement vibration. The study also summarizes key considerations for practical measurements, including equipment waterproofing, heat dissipation, sampling rate selection, and measurement safety. These measures effectively ensure data quality and continuity, providing a viable technical solution for ocean current velocity monitoring.

KEYWORDS

Power supply; Equipment mounting; Ocean current.

1. FLOW VELOCITY MEASUREMENT INSTRUMENT

Flow velocity is measured using the Vectrino Doppler Point Velocimeter, a product of Nortek AS, Norway. The Nortek Vectrino Velocimeter is a high-precision 3D point-type flow velocity meter manufactured by Norway's Nortek AS. It serves as an upgraded replacement for older NDV and ADV (Acoustic Doppler Velocimeters, point-type flow meters produced by SonTek/YSI). The Vectrino Doppler Point Velocimeter employs acoustic Doppler measurement principles, utilizing the Doppler frequency shift of sound waves in flowing liquids to measure velocity. Its advantages include automatic sound velocity calibration, continuous data logging, no moving parts, absence of friction or hysteresis, rapid measurement response, high data accuracy, and zero drift in the instrument itself. The Vectrino Doppler Point Flow Meter features a small sampling volume (less than 1 cm^3). The Vectrino Doppler Point Flow Meter operates at a sampling frequency of 0–200 Hz. Each measurement point undergoes a 15-second continuous velocity measurement, yielding 3,000 data points. Using the Data Conversion command in the instrument's software, these are processed into a velocity series comprising 9,000 velocity values. The compact probe size of the Vectrino mini Doppler point velocity meter significantly reduces interference caused by the probe itself.

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The Vectrino consists of two core components: the sensor and the internal processing card within the probe. This design ensures that data transmitted directly from the probe to a PC or data logger is processed rather than raw analog signals. The instrument includes computer software for parameter configuration, file naming, monitoring, and recording velocity changes over time.

2. POWER SUPPLY AND MOUNTING BRACKET REQUIRED FOR MEASUREMENT

Preparations for flowmeter measurement involve two aspects: firstly, a power supply for sea trials; secondly, a removable mounting bracket designed for sea trial applications.

2.1. Power Supply for Sea Trials

Regarding power supply, the current meter itself consumes only 2.5W. However, the laptop used to record experimental data operates at an unstable maximum power of 125W, with the monitor consuming 20W. When connected to the current meter for data logging, the estimated power consumption ranges from 50W to 80W. Additionally, the monitor is configured to automatically shut down during recording. Thus, the entire system requires low-power, long-duration uninterrupted power supply (UPS) with a minimum runtime of 24 hours. However, standard UPS units, typically designed for office or emergency use, are characterized by high-power, short-duration supply. Additionally, battery life is significantly reduced under conditions of low-current, long-duration discharge. Consequently, specific research was conducted on the selection of appropriate batteries and UPS components. The project team specifically selected components based on battery discharge current and duration. The final configuration comprises an MT1000S UPS paired with four Santak 100AH batteries, ensuring the current meter operates continuously for over 24 hours. Batteries are replaced daily, with the removed units recharged to maintain system stability.

2.2. Detachable Mounting Bracket for Doppler Current Profiler Sea Trials

The mounting bracket must secure to existing cage frames while stably holding the current profiler probe. Its dimensions were designed based on cage frame height, profiler size, and the need to measure currents at 4m below the water surface. While marine-grade corrosion-resistant 316L stainless steel is ideal for the bracket material, the project opted for galvanized steel plate due to the non-permanent nature of the trial. Initial plans to use angle iron were revised later, as its dual-point fixation might prove insufficiently robust. To facilitate transportation, each fabricated bracket must not exceed 2m in length or 1.5m in width. Rather than employing conventional bolted connections—which would significantly weaken the structure through drilling and risk fracture under ocean current impacts—rectangular interlocking joints secured with galvanized steel wire were adopted. During testing, a 4-meter-long galvanized steel pipe was added to reinforce the vertical arm of the support frame, effectively mitigating flow measurement instability caused by arm vibration.

3. PRECAUTIONS DURING MEASUREMENT

Upon reaching the target sea area, the project team precisely measured the latitude and longitude of the measurement point, located 4 meters below the water surface. The team installed the mounting bracket and securely fastened the steel reinforcement pipe. Using a compass, they verified the bracket's orientation. When securing the current meter, they ensured its X-axis pointed north. After installation, the X-axis direction for current velocity measurements was confirmed as 30° west of north. Batteries, UPS units, and recording computers were deployed. The UPS and recording computer were placed inside a logistics container. Connecting cables were carefully wrapped with shock-absorbing foam packaging cloth along the outer edges of the container to prevent wear caused by platform vibrations during measurements. Given harsh sea conditions, initial attempts to cover the recording system with canvas failed to effectively mitigate rain and wave impacts, leading to computer malfunctions. Later, covering the recording system with a larger logistics box effectively solved the waterproofing issue. However, this approach resulted in poor ventilation for the entire system. The UPS and recording computer continuously emitted heat during operation, causing the system to pause due to overheating during intense midday sunlight. Fortunately, since the measurement period occurred in the relatively mild temperatures of April and May, this problem was not particularly prominent. Regarding signal sampling, the Doppler point-type current meter employed for this measurement allowed only long-term observation at a single point 4 meters underwater. Preliminary measurements of flow velocities at different depths were conducted by moving the current meter up and down. However, the Xiaoweilong Doppler point-type current meter is primarily designed for flow field research under ideal laboratory conditions. Compared to field-oriented models like the Weilong Doppler point-type current meter (which comes standard with a compass, inclinometer, pressure and temperature sensors, and supports both self-contained and online measurement), it lacks compass and inclinometer functions, resulting in poorer data quality. Additionally, its probe is not sufficiently robust for handheld operation at sea during 0–4m velocity measurements, posing a high risk of damage.

Regarding sampling rate, the instrument's optimal setting (200Hz) was employed for this measurement. While this posed certain challenges for subsequent processing, it maximized data sampling quality and preserved superior research samples for future studies in wave dynamics, wave trajectory analysis, boundary layer flow investigations, turbulence research, and combined wave-current monitoring.

Daily access to the measurement platform required traveling by raft or small boat to read recorded data and replace batteries. For safety reasons, this could only be done during daylight hours. Furthermore, the raft or boat dock was only accessible safely around high tide, and operations were impossible during strong winds—particularly southerly winds—which significantly impacted measurement continuity.

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