

Galvanic Current Density Measurements of Anode for Subsea Vibration Data Logger (SVDL) System

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ABSTRACT

In deep-water applications in the Gulf of Mexico, vibration-induced fatigue issues often arise due to wave induced motion, vessel induced motion, vortex induced vibration, and/or flow induced vibration. A purpose-built vibration monitoring system, Subsea Vibration Data Logger (SVDL), can be installed directly on subsea equipment to monitor these and other forms of vibration and to assess fatigue. The SVDL body is constructed from stainless steel (SS) and nickel-aluminum bronze (NAB) materials.

Because the SVDL system can be installed at locations ranging from the surface to deep-water, it is subject to a range of temperatures 4–27°C. To protect the SVDL from corrosion in seawater, the system is electrically isolated from the main structure and aluminum anodes are connected to the SVDL body. Based on exposure time and seawater temperature, the size of the anode and its exposed area are very important for protecting the SVDL materials.

This study presents results from laboratory electrochemical corrosion testing involving galvanic current density measurements for various anode/cathode area ratios. 1000 series aluminum anodes and three cathode materials, super duplex SS (UNS S32550), 316L SS (UNS 31603) and NAB (UNS C63000), were studied. The laboratory tests were performed at two seawater temperatures, 4°C and 24°C, and three anode:cathode area ratios.

Galvanic current densities and corrosion rates from the testing indicated that aluminum anodes provide effective corrosion protection to super duplex SS and 316L SS. An equal-area aluminum anode was found to be sufficient to protect the NAB material at both temperatures. Test results also indicated that there is no significant galvanic effect between the NAB and super duplex SS in the SVDL system.

Keywords: Subsea Vibration Data Logger (SVDL), anode, cathode, galvanic couple, galvanic current density, stainless steel, aluminum, seawater

INTRODUCTION

The Subsea Vibration Data Logger (SVDL) system¹ is a purpose-built vibration monitoring system that is installed directly on subsea equipment to measure and record vibration data at a particular location and to then assess fatigue (Figure 1). The SVDL body (Figure 2) is constructed from 316L SS (UNS S31603), super duplex SS (UNS S32550), and NAB material (UNS C63000). During service in seawater, the SVDL is protected from corrosion by attached aluminum anodes.

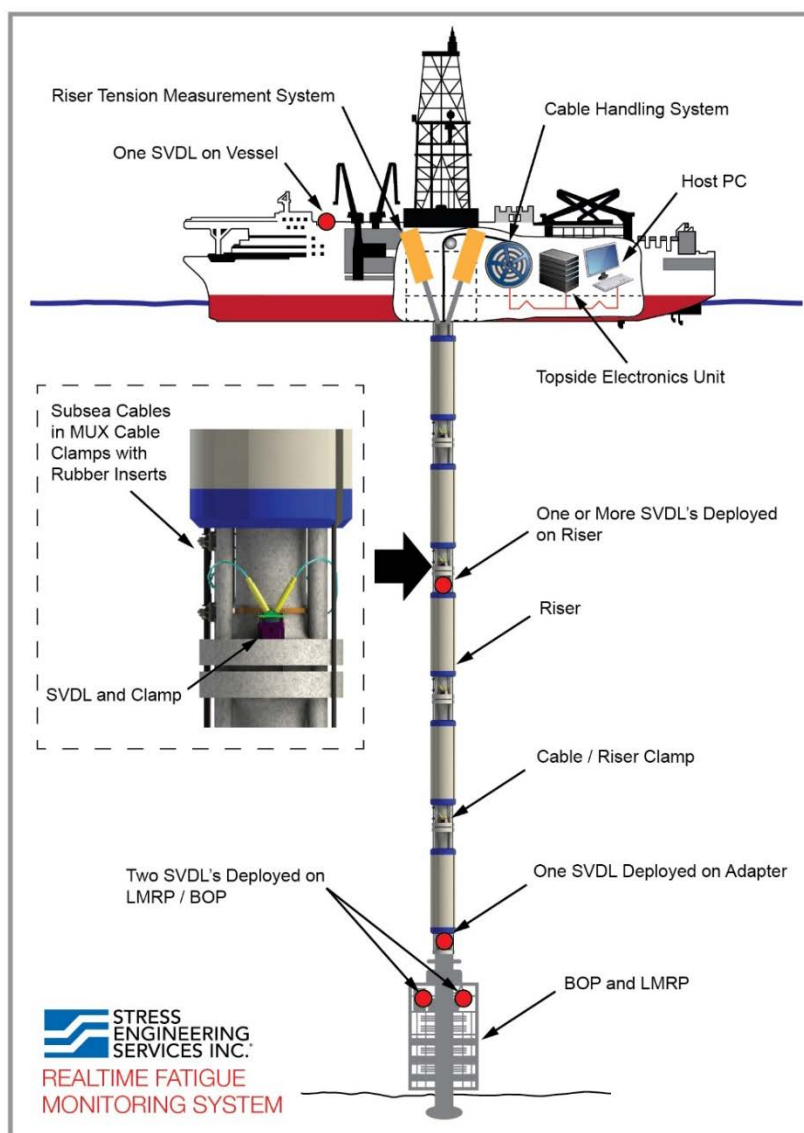


Figure 1. SVDL system installed on a drilling riser.²

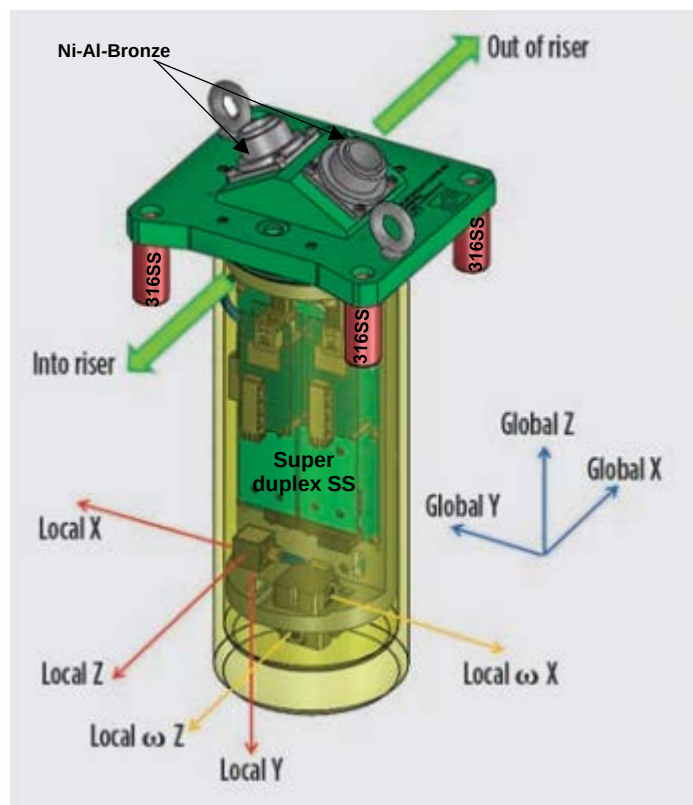


Figure 2. Body of SVDL.³

In this study, laboratory electrochemical corrosion testing was performed to measure the galvanic current density using a commercially available 1000 series aluminum anode in combination with various cathodes including SD255 super duplex SS, 316L SS and NAB at two seawater temperatures and three anode:cathode area ratios.

TEST SET-UP

Electrochemical galvanic corrosion testing was performed in accordance with ASTM G71-81⁴ in synthetic seawater (ASTM D1141) using the anode and cathode materials described above. All sample electrodes consisted of solid rods with the same surface finish (machined surface).

The test matrix for the galvanic corrosion tests is provided in Table 1. Tests were performed at two temperatures, 4°C and 24°C, under no or low flow conditions. Each test was performed for a total of 360 minutes. An electrochemical set-up comprising two electrodes was used; a schematic of the test cell is shown in Figure 3. The potentials were measured using a saturated calomel electrode (SCE).