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May 2020

Nutrien Ltd.
Swift Creek Mine Float Plant
15843 SE 78th Street
White Springs, Florida 32096-2703
ATTN: Mr. Ken Tut
Project Representative

Swift Creek Mine Float Plant
Effectiveness of Cathodic Protection
Survey Underground Natural Gas System

INTRODUCTION

The annual cathodic protection survey was conducted for Nutrien Ltd. – Swift Creek Mine Float Plant beginning May 5, 2020. During this survey, the Swift Creek Mine Float Plant natural gas system was inspected for the effectiveness of cathodic protection, as applied. The cathodic protection system for the Swift Creek Mine Float Plant consists essentially of Galvomag Magnesium anodes placed in various locations throughout the natural gas system.

RESULTS AND ANALYSIS

A total of Fifteen [15] cathodic protection voltage readings, Three [3] Galvomag anode / CTP readings, Five [5] gas casing pipe readings and Seven [7] gas pipeline readings were taken during this survey. As can be seen by the structure-to-soil potential measurements and the enclosed data sheet, 100% of the gas pipeline readings obtained are indicative of cathodic protection. A structure-to-soil potential of 850 millivolts [-0.850] or more negative direct current is the basis used in this report to confirm cathodic protection.

IR DROP CONSIDERATION

Aging pipes and changing conditions can cause significant problems, such as an increase in applied CP levels and enlarged holidays in coating. In addition, increased environmental concerns also emphasize the need to minimize leaks as much as possible.

The effectiveness of any cathodic protection system can be determined by taking potential measurements between the structure and a reference electrode. These potential measurements have traditionally been recorded with “average reading” digital voltmeters while the protective current is flowing or applied. These potential measurements contain the error produced by the voltage drop in the soil (electrolyte resistance) and the voltage drop (current) in the structure being protected. This error is referred to as *IR* drop. Interpretation of a current applied measurement requires consideration of the significance of voltage drops in the earth and metallic paths.

An *IR* drop is a voltage across a resistance, in accordance with Ohm’s law ($V=IR$). Although there are several *IR* drops in a structure-to-electrolyte potential circuit, the *IR* drop of most concern is that which occurs between the reference electrode (half-cell) and the structure-to-electrolyte (pipe) boundary. This *IR* drop is due to a CP current in the resistance of the electrolyte and is an error in the measurement.

One way to reduce the *IR* drop is to bring the reference electrode close to the structure (pipe) to reduce the resistance of the electrolyte (soil). Another way to reduce the *IR* drop is to bring the current to zero by interrupting all sources of current (anodes) influencing that reference point at the same precise time.

An instant off-potential measurement is the reading taken instantaneously after the protective current reaches zero. Off-potential measurements eliminate the *IR* drop error, allowing the true *IR* drop free polarized potential of a cathodically protected structure to be determined in the field. *IR* drop error is eliminated since there is no current flowing when the measurement is taken (i.e. $I = 0$ A, then $IR = 0$ V).

SURVEY TEST INSTRUMENTATION

The Cathodic Protection Analyzer, developed by Universal Rectifiers, Inc, (Hereinafter referred to as CPA), is a handheld instrument used with a reference electrode to measure the uninterrupted characteristics of the signal generated from a CP source. It can be used to evaluate the coating of a pipeline to ensure that the pipe is fully protected from corrosion. The CPA is designed for use with any pipeline system or structure at risk to corrosion factors. Aging pipes and changing conditions can cause significant problems, such as an increase in applied CP levels and enlarged holidays in coating. In addition, increased environmental concerns also emphasize the need to minimize leaks as much as possible.

The CPA has computer capabilities of filtering interfering signals. The instrument is also capable of measuring several facets of the protection waveform. The software-driven instrument reads the minimum, average, and maximum voltage levels emanating from the pipe, thereby allowing an overview of the entire CPv signature. Digital signal processing makes the accuracy and precision of the CPA possible. It utilizes software to provide the extra speed and flexibility that is becoming increasingly important in the field.

The CPA is operated in conjunction with a Copper – Copper Sulfate [Cu/CuSO₄] shielded reference electrode known by its model number SPI, which allows the measurement of the cathodic protection voltage without interrupting the potential source.

RECOMMENDATIONS

Nutrien Ltd. – Swift Creek Mine Float Plant
Underground Natural Gas System
May 2020

The sacrificial galvanic anode arrangement designed to protect the coated and wrapped steel natural gas system indicates adequate current to afford cathodic protection to the steel distribution system. Structure-to-soil readings obtained from Cathodic Test Points and gas risers on the steel distribution system indicate CP readings above State and Federal minimum standards of -0.850 volts direct current. Five [5] gas pipeline casings, Three [3] Galvomag anodes / Cathodic Test Points and Seven [7] gas pipeline contacts were inspected during this survey.

The coated and wrapped main lines show a minimum *IR* drop free structure-to-soil potential of -1.094 vdc and a maximum *IR* drop free structure-to-soil potential of -1.241 vdc at various Cathodic Test Points in the Swift Creek Mine Float Plant distribution system. Continuity over the entire main line system is fair to good.

At the time of survey, the Natural Gas Distribution System for Nutrien Ltd.'s Swift Creek Mine Float Plant complex indicates cathodic protection levels exceeding State and Federal minimum guidelines for applied cathodic protection. I trust the above information to be satisfactory and in sufficient detail, however, should you require additional information, please contact me.

Sincerely,



Mitchell Whitfield
C.P. Tester

CATHODIC TEST POINTS

CATHODIC TEST POINTS

Nutrien Ltd. – Swift Creek Mine Float Plant
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Cathodic Test Point - #1

Black Anode Connection	-1.234 Vdc
Black Gas Pipeline Connection	-1.094 Vdc
White Casing Pipe Connection	-0.608 Vdc

Cathodic Test Point - #2

Black Anode Connection	-1.266 Vdc
Black Gas Pipeline Connection	-1.237 Vdc
White Casing Pipe Connection	-0.518 Vdc

Cathodic Test Point - #3

Black Anode Connection	-1.419 Vdc
Green Gas Pipeline Connection	-1.200 Vdc

STRUCTURE-TO-SOIL POTENTIALS
GAS PIPE CASINGS

**STRUCTURE-TO-SOIL POTENTIAL
GAS PIPE CASINGS**

Nutrien Ltd. – Swift Creek Mine Float Plant
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May 2020

<u>Test Location</u>	<u>Energized Potentials Volts</u>
Railroad Casing - #1	-0.533
Railroad Casing - #2	-0.498
Highway Casing - #3	-0.513

STRUCTURE - TO - SOIL POTENTIAL DATA

STRUCTURE – TO – SOIL POTENTIAL DATA

Nutrien Ltd. – Swift Creek Mine Float Plant

Underground Natural Gas System

May 2020

<u>Test Location</u>	<u>Energized Potentials Volts</u>
Gas Metering Station - Inlet	-1.239
Gas Metering Station – Outlet	-1.186
4” Gas Riser @ Plant	-1.231
2” Gas Riser @ Boiler Room	-1.241