Regulatory Information

Permit No.	Michigan Department of Environment, Great Lakes, and Energy (EGLE) Air Quality Division Renewable Operating Permit MI-ROP-A8640-2016a

Source Information

Source Name	*Target Parameter*
Vacuum Degasser Flare Stack	CO

Contact Information

Test Location
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Alliance Technical Group, LLC (Alliance) has completed the source testing as described in this report. Results apply only to the source(s) tested and operating condition(s) for the specific test date(s) and time(s) identified within this report. All results are intended to be considered in their entirety, and Alliance is not responsible for use of less than the complete test report without written consent. This report shall not be reproduced in full or in part without written approval from the customer.

To the best of my knowledge and abilities, all information, facts and test data are correct. Data presented in this report has been checked for completeness and is accurate, error-free and legible. Onsite testing was conducted in accordance with approved internal Standard Operating Procedures. Any deviations or problems are detailed in the relevant sections in the test report.

This report is only considered valid once an authorized representative of Alliance has signed in the space provided below; any other version is considered draft. This document was prepared in portable document format (.pdf) and contains pages as identified in the bottom footer of this document.

Adam Robinson
Alliance Technical Group, LLC

September 15, 2022
Date

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Introduction

1.0 Introduction

Alliance Technical Group, LLC (Alliance) was retained by Cleveland-Cliffs - Dearborn Works to conduct compliance testing at the Dearborn, Michigan facility. The testing is subject to provisions of the Michigan Department of Environment, Great Lakes, and Energy (EGLE) Air Quality Division Renewable Operating Permit MI-ROP-A8640-2016a. Testing was conducted to determine the emission rate of carbon monoxide (CO) from the Vacuum Degasser.

1.1 Facility Description

The recirculation vacuum degasser process removes gases which are normally dissolved in steel. The first step in the process is the lowering of the vacuum vessel into the ladle of liquid steel. The vessel has two nozzles in which the liquid steel flows. The air in the vessel is evacuated, and as the pressure inside the vessel decreases, columns of liquid steel rise up the nozzles. In order to achieve the required flow of liquid steel through the vacuum vessel, argon gas is injected into the steel through one of the nozzles. This action produces a recirculatory flow of steel from the ladle through the vacuum vessel and back to the ladle. Dissolved gasses (primarily oxygen, via carbon monoxide) are removed, and alloying additions are introduced. The gases are then exhausted through a "flare stack" for CO control before exiting to the atmosphere.

1.2 Project Team

Personnel involved in this project are identified in the following table.

Table 1-1: Project Team

Facility Personnel	David Pate
Alliance Personnel	Matt McDivitt John Wilson

1.3 Site Specific Test Plan & Notification

Testing was conducted in accordance with the Site-Specific Test Plan (SSTP) submitted to EGLE on July 14, 2022.

Summary of Results

2.0 Summary of Results

Alliance conducted compliance testing at the Cleveland-Cliffs - Dearborn Works facility in Dearborn, MI on August 17, 2022. Testing consisted of determining the emission rates of CO at the exhaust of the Vacuum Degasser prior to the flare. Emissions from the flare exhaust are calculated based on a 99.5 destruction efficiency.

Table 2-1 provides a summary of the emission testing results with comparisons to the applicable EGLE permit limits. This table also provides a summary of the process operating and control system data collected during testing. Any difference between the summary results listed in the following table and the detailed results contained in appendices is due to rounding for presentation.

Table 2-1: Summary of Results

Emissions Data				
Run Number	**Run 1**	**Run 2**	**Run 3**	**Average**
Date	**8/17/22**	**8/17/22**	**8/17/22**	**--**
Carbon Monoxide Data				
Concentration, ppmvd	66750.0	69650.0	60600.0	65666.7
Emission Rate, lb/hr	294.5	257.7	210.9	254.3
Emission Rate, lb/hr (based on 99.5% D.E)	1.47	1.29	1.05	1.27
Permit Limit, lb/hr	--	--	--	2.42
Percent of Limit, %	--	--	--	**53**
Process Operating / Control System Data				
Run Number	**Run 1**	**Run 2**	**Run 3**	**Average**
Date	**8/17/22**	**8/17/22**	**8/17/22**	**--**
Tons Processed	496	491	487	491
Production Rate, tons/hr	487.4	491.1	479.2	485.9
Argon Injection Rate	38.72	39.03	38.15	38.63

Testing Methodology

3.0 Testing Methodology

The emission testing program was conducted in accordance with the test methods listed in Table 3-1. Method descriptions are provided below while quality assurance/quality control data is provided in Appendix D.

Table 3-1: Source Testing Methodology

Parameter	U.S. EPA Reference Test Methods	Notes/Remarks
Volumetric Flow Rate	1-2	Full Velocity Traverses
Oxygen/Carbon Dioxide/Carbon Monoxide	3B	Instrumental Analysis
Moisture Content	4	Gravimetric Analysis
Oxygen/Carbon Dioxide/Carbon Monoxide	10B	Instrumental Analysis

3.1 U.S. EPA Reference Test Methods 1 and 2 – Sampling/Traverse Points and Volumetric Flow Rate

The sampling location and number of traverse (sampling) points were selected in accordance with U.S. EPA Reference Test Method 1. To determine the minimum number of traverse points, the upstream and downstream distances were equated into equivalent diameters and compared to Figure 1-1 (for isokinetic sampling) and/or Figure 1-2 (measuring velocity alone) in U.S. EPA Reference Test Method 1.

Full velocity traverses were conducted in accordance with U.S. EPA Reference Test Method 2 to determine the average stack gas velocity pressure, static pressure and temperature. The velocity and static pressure measurement system consisted of a pitot tube and inclined manometer. The stack gas temperature was measured with a K-type thermocouple and pyrometer.

Stack gas velocity pressure and temperature readings were recorded during each test run. The data collected was utilized to calculate the volumetric flow rate in accordance with U.S. EPA Reference Test Method 2.

3.2 U.S. EPA Reference Test Method 3B – Oxygen/Carbon Dioxide/Carbon Monoxide

EPA Reference Method 3B, "Gas Analysis for the Determination of Emission Rate Correction Factor or Excess Air," was used to determine the carbon dioxide (CO_2), oxygen (O_2), carbon monoxide (CO) concentrations. Samples were collected in Tedlar bags over the span of one batch. The bags were then sent to an off-site lab where they were analyzed using gas chromatography.

3.3 U.S. EPA Reference Test Method 4 – Moisture Content

The stack gas moisture content (BWS) was determined in accordance with U.S. EPA Reference Test Method 4. The gas conditioning train consisted of a series of chilled impingers. Prior to testing, each impinger was filled with a known quantity of water or silica gel. Each impinger was analyzed gravimetrically before and after each test run on the same balance to determine the amount of moisture condensed.

3.4 U.S. EPA Reference Test Method 10B – Carbon Monoxide

An integrated gas sample was extracted from the sampling point, passed through a conditioning system to remove interferences, and collected in a Tedlar or equivalent bag. The CO was separated from the sample by gas chromatography (GC) and catalytically reduced to methane (CH4) which was determined by flame ionization detection (FID). The analytical portion of this method was identical to applicable sections in Method 25 detailing

CO measurement. CO is reported in units of pounds per hour for each batch. Each run average is the arithmetic average of the batches tested during the run. CO emissions exiting the flare were be calculated based on an assumed destruction efficiency of 99.5%.