DETERMINATION OF CONTROL SYSTEM EFFICIENCY USING LIQUID CO2 INJECTION

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1. INTRODUCTION

Steel manufacturing is an indicator of country's economic development, with that being an iron and carbon alloy, with less than 2% carbon and less than 1% of elements such as silicon, manganese, phosphorus and sulfur. During the steelmaking production process, which goes from the preparation of the raw material to its storage, there is generation of fugitive emissions. One of steelmaking processes that requires attention is the production of pig iron, an alloy used as an input for steel production.

The production of pig iron in the liquid phase is considered an emission source, both in its production and on the converting process of pig iron, in an area known as the pig iron converting yard. When the material is not within the established standards, they are sent to specific yards, properly prepared to receive it. The converting of pig iron are taken by torpedo cars and causes great movement of the liquid metal, promoting the detachment of particles and, consequently, the emission of particulate material.

This study aims to determine the efficiency of the system control using liquid CO_2 injection in pig iron converting process, through comparative tests in the converting yard of a steel mill plant.

2. MATERIALS AND METHODOLOGY

OTM 32 - Exposure Profiling Method (US EPA, 2013) is one of the best methods to monitor fugitive emissions. This method was developed to measure pollutant open source emissions, with exposure defined as the time-integrated mass flux of a pollutant at a sampling point.

To consolidate the model, two vertical towers were placed downwind the source, in a sampling plane perpendicular oriented to the sampling time wind direction average, as shown in Figure 1.

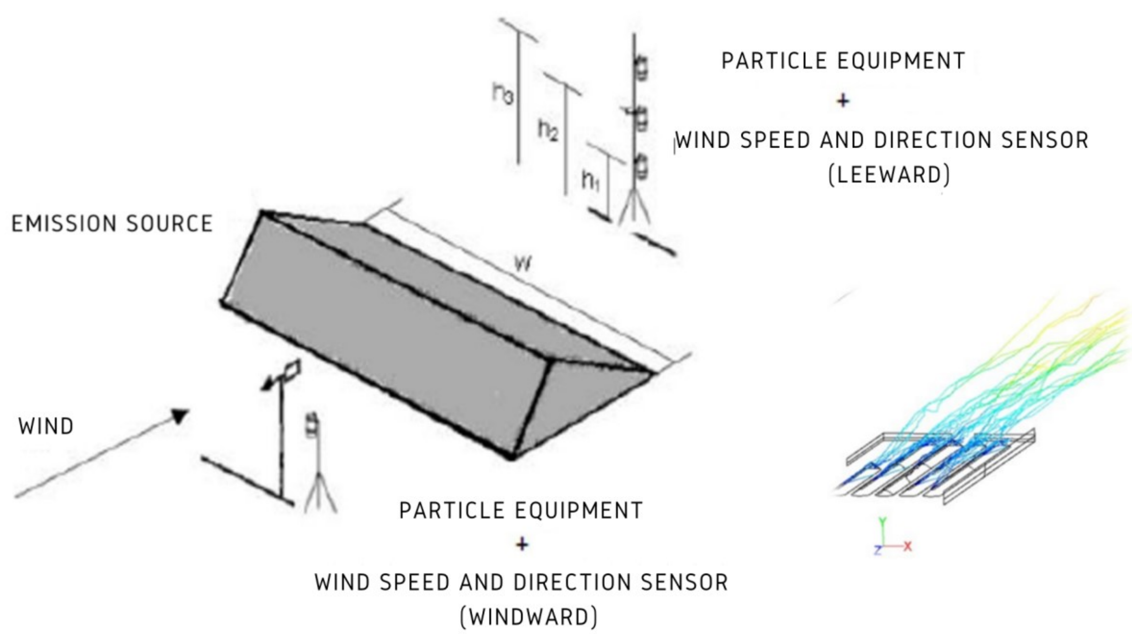

Fig. 1. Open source measurement scheme - Exposure profile method.

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The particle emission rate was obtained by the spatial integration of the distributed exposure measurements (accumulated mass flow), which is mass concentration and wind speed product, according to the Equation 1 below:

$$R = \int_A C(h, w)\, u(h.w)\, dh\, dw$$

Where:
R = emission rate, µg/s
C = net particle concentration, µg/m^3
u = wind speed, m/s
h = vertical distance coordinate, m
w = lateral distance coordinate, m
A = effective cross-sectional area of the plume, m^2

To perform the application of the method, the sampling equipment must be placed close to the monitored source. It is also necessary that the wind conditions are such that the horizontal advection of the emitted pollutant is consistent enough to provide transport through the sampling point. This methodology also requires that the samplers are positioned in the wind direction in relation to the source, with the smallest possible downwind distance.

The equipment used to execute the monitoring was the GM-5000, by Thermo Fisher Scientific.

This complete and compact air pollutant automatic monitoring station continuously measures different pollutants, including gases and particles.

The equipment were installed in the pig iron tipping yard at heights of 7 and 10 meters. Monitoring was carried out during a period of 2 hours before the converting process and 2 hours after its finalization.

3. RESULTS AND DISCUSSIONS

Tests were performed with and without liquid CO_2 injection. It was monitored concentrations of different particulate matter fractions: Total Suspended Particles (TSP), Inhalable Particles (PM_{10}) and Respirable Particles ($PM_{2.5}$).

Tests with and without CO_2 application were compared. The comparative analysis allowed to identify the differences in particulate concentrations and emission rates. The results showed concentrations percentage decay of 90% for TPS, 91% for PM_{10} and 115% for $PM_{2.5}$. As for the particulate matter emission rate, it was obtained a percentage drop of 90% for TPS, 91% of PM_{10} and 100% of $PM_{2.5}$.

Na Figure 2 its possible see the liquid CO_2 injection.

Fig. 2. Liquid CO2 injection.

4. CONCLUSION

The results of the tests without the application of liquid CO_2 showed that the high temperatures reached by pig iron elevates the vertical gradient plume dispersion, provoking a quick rise of the plume and less horizontal reach.
As expected, it was noticed the increase of particulate matter concentration during the pig iron converting without the CO_2 injection.

5. REFERENCES

USEPA. Miscellaneous Sources: Industrial Wind erosion. United States, 2006.

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