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Minister Stein Pushing Control Device

P-4641

Report P-3016/I-2

Determination of Emissions from the Coke Pushing Control System

for

Dominion Foundries and Steel Limited
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February 8, 1979.

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Determination of Emissions
from Coke Pushing Control
System
(Proposal P-3016/I)

for

Dominion Foundries & Steel Ltd.

1. SUMMARY

A test programme has been carried out at Dofasco's #3 Coke Battery #6 Plant. The emission rate of particulate from the emission control system was determined and an estimate made of the venturi scrubber efficiency based on emission rate data and scrubber water solids content. Duplicate particulate tests were carried out with a second sampling train to provide the Ministry of the Environment with samples for polynuclear aromatic hydrocarbon (PAH) analysis.

The average particulate concentration and emission rate from the two particulate tests were determined to be 0.005 gr/scf and 5.4 lb/hr, respectively. This average loading is well below the designed outlet loading of 0.02 gr/scf. 145,000 scfm

Due to the variation of results obtained from analyses of scrubber water samples for solids content, the venturi efficiency was calculated to be in the range of 86% to 96%. 98.5 to 99.3

When the Ministry of the Environment have completed PAH analyses, the results will be submitted directly to Dofasco.

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January 22, 1979.

2. INTRODUCTION

At the request of Dominion Foundries and Steel Limited (Dofasco) and the Ontario Ministry of the Environment (MOE), a test programme was carried out during the period, December 1 - 5, 1978, on coke pushing emissions from #3 Coke Plant. The major objective of the test programme was to determine the emission rate of particulate from the emission control system.

In addition, inlet loadings to the venturi scrubber were to be estimated by measuring the solids contents of effluent water samples. The collection efficiency of the scrubber could then be calculated from inlet and outlet particulate loading data.

The analysis of all collected samples for particulate matter was performed by Ontario Research (ORF). The samples from two tests were then submitted to MOE for polynuclear aromatic hydrocarbon (PAH) analysis.

This report presents a detailed discussion of the process operation, emission rates and control system efficiency and includes descriptions of sampling and analytical procedures.

3. PROCESS DESCRIPTION

Coke, an essential raw material for blast furnace pig iron production, is produced by the destruction distillation of coal under a reducing atmosphere.

Coking is a batchwise operation and takes place in a series of slot-type coke oven batteries. The coking period is approximately 16 hours and temperatures reach 2000°F. Heat is supplied indirectly from a gas fired regenerative system located below the ovens with flues between the ovens.

A typical cycle would be as follows: an empty oven is charged with approximately 36 tons of coal by the larry car, travelling on rails on top of the battery, and the oven heated. During heating, volatiles are driven off the coal. At the end of the coking cycle, the coked coal is removed. This involves close communication between the operators of the door machine, quench car locomotive (loco) and pusher. When the pusher is positioned in front of the oven to be pushed, the door machine is contacted by radio. The door machine mechanically removes the oven door. Once the door is removed, emissions leak from the oven. The door machine informs the loco that the oven is ready to be pushed. The loco positions the far end of the coke collection car (quench car) adjacent to the coke guide. Once in position, the loco contacts the pusher. The pusher, on the opposite side of the battery, will then proceed to push the coke out of the oven by a mechanized ram. As the incandescent coke is pushed, it breaks up and falls into the quench car. Once full, the loco travels to the quench station where the coke is cooled by water sprays. The time interval between removing the oven door and completing the coke push into the quench car is approximately two minutes. The actual pushing of the coke lasts approximately one minute.

Coke dusts and volatiles are carried upward by thermal rise when the oven door is removed and during pushing. In order to collect and control these emissions, a complex system of ductwork and venturi scrubber was installed during construction of the new battery.

A stationary gas collecting duct (approximately 4.5 ft diameter) is located above the loco tracks and extends from the quench station to the far end of the battery. The top of the duct is grating material and covered by a high temperature resistant rubber mat. The travelling hood, which collects the emissions, is attached to the collecting duct. A series of rollers picks up the rubber mat, allowing the collected emissions to enter the collecting duct anywhere between the quench station and the coke ovens. This allows the hood to be stationary at the door machine to collect the pushing emissions and, after the quench car is full of coke, the loco can pick up the hood and travel to the quench station so that emissions given off during this period are collected.

The collected emissions are cleaned by a venturi scrubber and exhausted through a 150' stack. A schematic of the system is shown in Figure 1.

4. SAMPLING LOCATION

Sampling was carried out from a platform around the 6'8" diameter stack at the 118' level above grade. All four ports were used when traversing the stack to allow the use of short probes. The sampling location was 7 stack diameters upstream of a flow disturbance and 5 stack diameters downstream of the stack outlet. A schematic of the stack and sampling location is given in Figure 2.

5. SAMPLING AND ANALYTICAL METHODOLOGY

The test programme consisted of three distinct procedures; source sampling at the scrubber outlet, water sampling of the scrubber effluent and analysis of water samples and particulate samples for PAH compounds.

Due to the nature of testing required, it was decided to operate two stack sampling trains simultaneously. One train was operated from the moment that the door machine removed the oven door until the quench car was full of coke (Train A). The particulate loadings determined from tests using train A could then be compared with the maximum loading guaranteed by the system supplier. It was intended to operate the other train (Train B) for an additional length of time as the coke car travelled to the quench station so that an average emission factor per push, as requested by MOE, could be obtained. However, because of problems with the travelling hood at the time of sampling, emissions from the travelling quench car could not be sampled. The two trains were, therefore, operated over the same time period.

Due to the short sampling duration (approximately 2 minutes) for Train A, it was intended to use a high-volume source assessment sampling system (SASS) train. This equipment has the capability of sampling at four times the sampling rate of conventional equipment. However, during preliminary evaluation of equipment on the stack, it was discovered that too much time was required to move the SASS train from one port to another when sampling all four ports. Therefore, it was decided to use two conventional EPA Method 5 trains to complete the test programme.

Train B was modified to incorporate a tenax adsorbent tube in the heated oven after the filter. Samples from this train were submitted to MOE for PAH analysis.

5.1 Particulate Sampling

Two Joy Emission Parameter Analyzers were used to collect the samples. A schematic of the conventional train is shown in Figure 3 and Figure 4 shows a schematic of the modified train. A Tenax adsorbent tube was inserted in the oven between the filter and the impingers to collect vapor phase PAHs which penetrated the particulate filter. A drawing of the tube is shown in Figure 5. Five foot stainless steel lined probes with a calibrated S-type pitot tube and temperature measuring device attached were used with both trains.

Twelve points at distances representing the middle of equal areas across the stack diameter were calculated. The first six points were marked on each probe because all four ports were used and each traverse would be one half the stack diameter. Each point was sampled from the time the oven door was removed for a period of two minutes. Unless problems occurred at the oven being pushed, the end of the two minute sampling period coincided with the coke car being full of coked coal. Therefore, each test represents twenty-four pushes.

Isokinetic sampling was maintained throughout all tests, using a 3/16" diameter nozzle on each probe. An average sampling flowrate was approximately 0.7 cfm.

Particulate matter was collected on 125 mm diameter glass fibre filters in a heated oven. The filters used in the PAH train were pre-extracted with benzene by MOE. All filters were conditioned in the laboratory prior to both the initial and final weighing.

At the start of each test, 125 mls of distilled water was put into each of the first two impingers. The third impinger was left dry and the fourth contained 250 gm of indicating silica gel.

5.2 Water Sampling

During each particulate test, a composite water sample was obtained from the continuous blowdown line of the effluent venturi scrubber water. An automatic water sampler, equipped with a timer, was connected to the blowdown line and a flow of approximately 18 gpm of scrubber effluent was diverted through the sampler. A motor driven dipper, connected to a timer, took a 25 ml sample of the water every 1-1/2 minutes. Each sample drained into a glass jar and approximately every four hours the sample jar was changed. A schematic of the water sampler is shown in Figure 6.

5.3 Sample Recovery

5.3.1 Particulate Train

The conventional particulate sampling train was cleaned up at the end of each test using normal procedures. The volume of water in the impingers was measured and recorded. All glassware after the filter was rinsed with distilled water and added to the impinger solutions. The silica gel was removed from the fourth impinger and placed in a pre-weighed, capped, plastic sample bottle.

The particulate filter was carefully removed from the filter holder and placed in a plastic petri dish. The probe and nozzle were rinsed with distilled water. A brush assembly was used when cleaning the probe to aid in recovery of particulate lodged in the liner.

5.3.2 PAH Train

The entire train was rinsed with spectro-grade benzene and then acetone prior to the start of the test. A final rinse was taken and kept as a blank.

Glass sample bottles were rinsed with spectro-grade benzene and acetone in the laboratory prior to the test programme. The caps were lined with teflon.

The recovery procedure used, as specified by MOE, was as follows:

1. The nozzle, probe and first half of the filter holder were rinsed with spectro-grade acetone and kept in a teflon capped glass container (Container #1).
2. A second rinse of the above components was made using spectro-grade benzene and kept in a teflon capped glass container (Container #2).
3. To ensure complete recovery, a "ball" of Kimwipe tissue paper, which had been wetted by spectro-grade benzene, was pushed through the probe and nozzle. The tissue was placed in a teflon capped glass container (Container #3).
4. The filter was placed in an enclosed glass petri dish (Container #4).
5. The adsorbent tube was capped with glass plugs.
6. The first disc, back half of the filter holder, and the connection leading to the adsorbent tube were rinsed with spectro-grade benzene into a teflon capped glass container (Container #5).
7. A second rinse of the above components was made using spectro-grade acetone and kept in a teflon capped glass container (Container #6).

wash of the nozzle, probe and front half of the filter holder was filtered to obtain the insoluble fraction of particulate. The soluble fraction was not determined. The total weight gain of particulate was obtained by adding the filter weight gain and the acetone probe rinse insolubles.

5.4.3 Venturi Effluent Water Samples

In the laboratory, the samples were shaken well and an aliquot taken for PAH analysis. The remaining portion of each sample was filtered to obtain the amount of particulate collected. The total volume of each sample was measured.

6. RESULTS AND DISCUSSION

During the testing period, a record of the oven pushes and net coking times was gathered. This information is given in Tables 1 and 2 for Tests 1 and 2 respectively. Since the particulate train and PAH train were operated simultaneously, the process data acquired is applicable for both trains.

A summary of the particulate weight gain in both trains is given in Table 3. In each case, the particulate caught on the filter, in the probe and a total weight gain is provided.

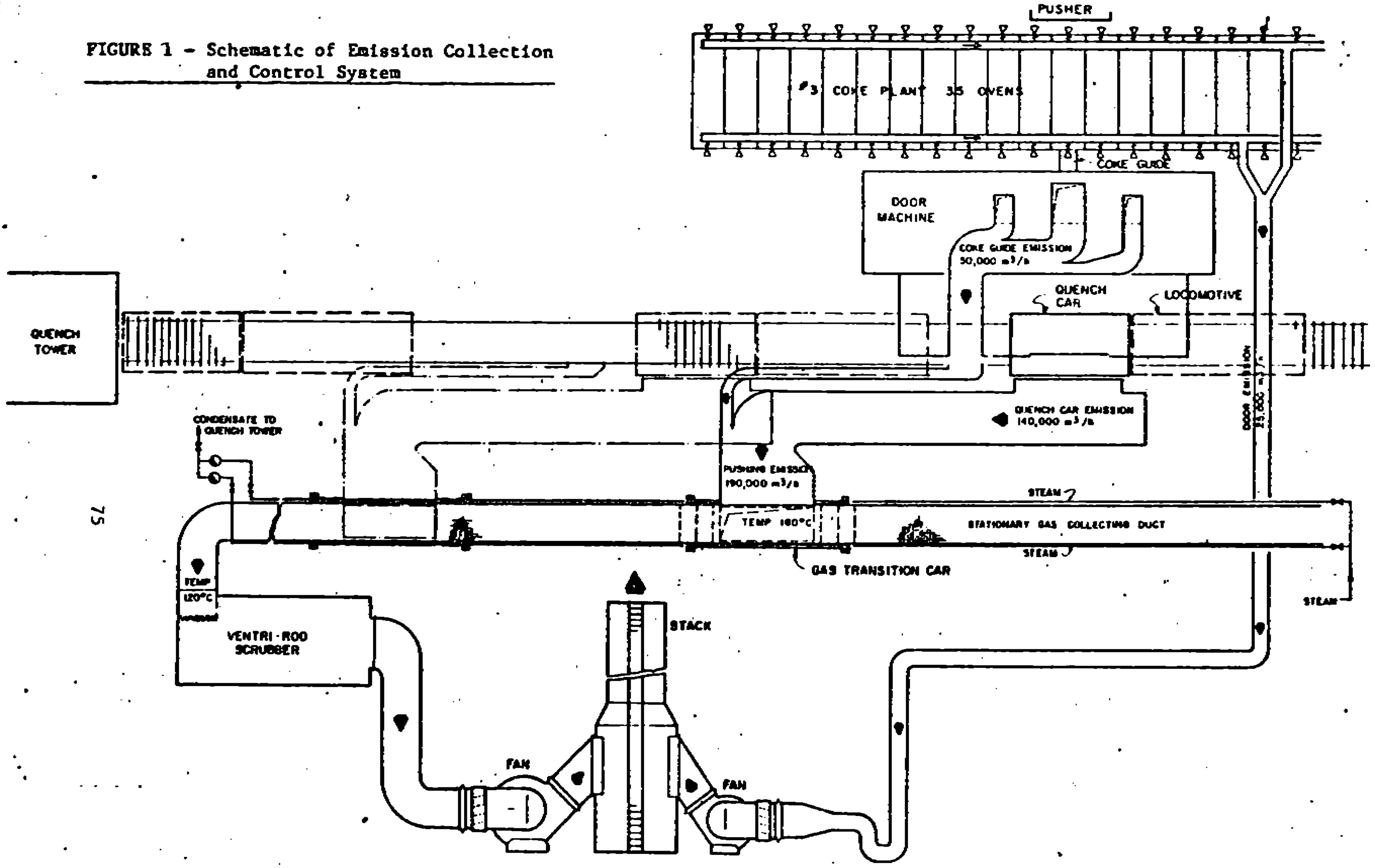
The calculated particulate concentrations and emission rates are given in Table 4, along with the stack gas flowrates at reference temperatures and pressures. The stack emission results from all tests are very close, ranging from 3.3 lb/hr to 5.7 lb/hr. The average stack gas concentration was found to be 0.005 gr/scf. This is well below the designed stack gas concentration of 0.02 gr/scf. A detailed presentation of the stack sampling field test data, calculations and isokineticity are given in Appendix A.

Inlet particulate emission rates to the venturi were calculated by adding the emission rate determined from the scrubber water samples and the stack emission rate. The scrubber water emission rate was determined from the product of the effluent flowrate and the concentration of particulate

TABLE 4 - Particulate Emission Rate Data

Test #	Concentration gr/scf	Flowrate scfm	Emission Rate lb/hr
1 Particulate Train	.005 ✓	142,000	5.5
1 PAH Train	.004 ✓	148,000	3.3
2 Particulate Train	.004 ✓	140,000	5.3
2 PAH Train	.005 ✓	148,000	5.7

FIGURE 1 - Schematic of Emission Collection and Control System



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